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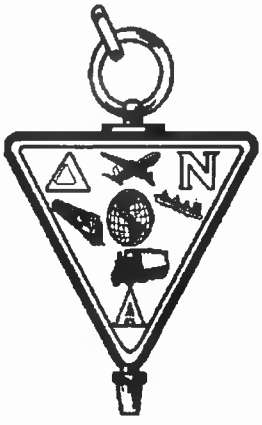

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From the Editor...

The events of September 11, 2001, will continue to influence our lives and livelihoods for many years to come. The tools of our industry were used on this day both as weapons of war and for aiding the survivors and their families. This issue of the *Journal of Transportation Management* is dedicated to all who lost their lives on that day and to the men and women of our industry who are working hard every day to keep this country strong. God Bless America!

Less than a week after the terrorist attacks. I was notified by Dana Campbell of the National Association of Small Trucking Companies [NASTC provides administrative services for Delta Nu Alpha] that a representative of the Library of Congress was seeking copies of an article published in the last issue of the *Journal* [Volume 12, Number 1, Spring 2000]. The article, entitled "Terrorism and the Global Supply Chain: Where Are Your Weak Links?" was written by Kay Dobie, Milt Glisson, and Jim Grant. More than one member of Congress had evidently requested the article. I sincerely hope that the timely information provided in the article can be of some value in the fight against terrorism. Thanks to Kay, Milt, and Jim for their work and for allowing it to be published in the *JTM*.

The subject matter of this issue is not as diverse as in recent issues. In fact, four of the five articles address topics in various parts of the trucking industry. The lead article in this issue, by Joe Hanna and Arnold Maltz, takes a look at service expansion attempts by LTL carriers in the U.S. over the last twenty-five years. Porter's differentiation strategy framework forms the basis for the research. The second article, by Patricia Poli and Carl Scheraga, uses data envelopment analysis to study the relationship between functional orientation of senior managers and service quality in U.S. LTL motor carriers. The results of the study indicate that, among the study participants, most LTL motor carriers are relatively inefficient in their configuration of senior level managers. Tom Lambert and Hokey Min address the impact of state taxes on the location of truck terminals and the registration and plating of commercial trucks in the third article. They use a case study they developed involving Kentucky as the basis for the discussion. Rick Clarke takes a look at the extent of EDI and Internet technology diffusion in the motor carrier industry in the fourth article of this issue. He reports the results of an email survey of 43 of the largest 75 U.S. motor carriers. In the final article of this issue, we finally leave land and head to sea! Shashi Kumar identifies several generic ocean common carrier business strategies and compares them to contemporary supply chain management practices. He also discusses the impact of the Ocean Shipping Reform Act of 1998 on ocean liner operations and strategy selection. As always, I hope you take the time to read each of the articles in this issue.

The DNA Board of Directors voted recently to increase the subscription price of the *JTM*. This price increase is the first in the history of the publication—it was a decision that needed to be made. Effective immediately, the price of a domestic subscription will rise to $50 per year, and international subscriptions will be $65 per year. We feel that the *Journal* is still very much a bargain at the new higher price. We hope that you will agree!

In closing, remember that we cannot survive and continue to publish without reader support. Please join or renew your membership in Delta Nu Alpha International Transportation Fraternity and subscribe to the *Journal of Transportation Management*. Remember that if you join DNA at the gold level, a subscription to the *JTM* is included in your membership! Share this issue with a colleague and encourage him or her to subscribe today!

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OBJECTIVES

Editorial Policy. The primary purpose of the *JTM* is to serve as a channel for the dissemination of information relevant to the management of transportation and logistics activities in any and all types of organizations. Articles accepted for publication will be of interest to both academicians and practitioners and will specifically address the managerial implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, would be inappropriate for the *JTM*.

Acceptable topics for submission include, but are not limited to carrier management, modal and Intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics and purchasing and materials management are acceptable as long as they are specifically related to the management of transportation and logistics activities.

Submissions from industry practitioners and from practitioners co-authoring with academicians are particularly encouraged in order to increase the interaction between the two groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

The opinions expressed in published articles are those of the authors and do not necessarily reflect the opinions of the Editor, the Editorial Review Board, Delta Nu Alpha Transportation Fraternity, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Department of Information Systems & Logistics, Georgia Southern University, P. O. Box 8152, Statesboro, GA 30460-8152. Manuscripts should be no longer than 25 double-spaced pages. Authors will be required to provide electronic versions of manuscripts accepted for publication. Guidelines for manuscript submission and publication can be found in the back of this issue.

Subscriptions. The *Journal of Transportation Management* is published twice yearly. The current annual subscription rate is $50 domestic and $65 international in U.S. currency. Payments are to be sent to the editor at the above address.

ANALYZING THE EVOLUTION OF CLASS I LTL MOTOR CARRIERS: AN EXAMINATION OF EXPANSION INTO WAREHOUSING

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ABSTRACT

The current research uses Porter's differentiation strategy framework to examine Class I LTL motor carrier service expansion habits over the last twenty years. The examination focuses on carriers bundling transportation and warehousing services together to help differentiate their service offerings from competitors. Results indicate that carriers are expanding service offerings to include warehousing services and are providing significant value-added services to customers. Continuous growth in warehouse service expansion was evident from passage of the Motor Carrier Act of 1980 to the mid-90's.

INTRODUCTION

Since deregulation in 1980 the market environment faced by motor carriers has changed dramatically (Corsi et al., 1991; Feitler et al., 1998; Harper, 1983; Sliverman et al., 1997). The environmental changes have altered relationships between shippers and carriers and created a mutual dependence (Crum and Allen, 1991). While the bulk of logistics research has typically focused on the shipper, motor carriers also face many new challenges (Corsi et al., 1991). Attracting and retaining customers is one of the most critical challenges facing carriers because it is vital to their long-term success (Stock, 1988). Carriers successful in meeting this challenge can build and maintain a solid customer base, enhancing the future outlook for the carrier (Rinehart, 1989).

Throughout the 1980's and 90's significant changes in the strategic orientation of motor carriers has occurred (Feitler et al., 1998; Silverman et al., 1997). Some carriers have attempted to attract and retain customers by pursuing strategies designed to differentiate themselves from competitors. They believe sufficient customization and/or bundling of services

may be one way to differentiate them from other carriers (Rinehart, 1989). There are several reasons why customizing or bundling services may help to retain customers.

First, many buyers of third-party logistics services are reducing their supplier bases (Delaney, 1998). Creating and maintaining a supplier relationship takes up valuable resources. The customer must identify potential suppliers, negotiate agreements, and process paperwork. Unless absolutely necessary, customers are increasingly reluctant to deplete resources to support a myriad of external logistics service providers. Instead they prefer to have a limited number of high quality external providers offer multiple services integrated together. To remain on their customers exclusive supplier list, some carriers are attempting to build long-term strategic alliances with key customers by bundling multiple logistics functions together to expand the availability of service offerings.

Second, carriers face significant competition from other carriers and integrated third-party logistics providers. Previous studies have examined the impact of integrated service providers on both logistics outsourcing usage (Leib and Maltz, 1998; Lieb and Randall, 1996; Sink and Langley, 1997) and motor carrier strategy (Feitler et al., 1998; Harper, 1983). Results of these studies indicate the third-party logistics market will continue to grow (Sink and Langley, 1997) and customers will be increasingly interested in "one-stop shopping" (Leib and Maltz, 1998). Many carriers want to take advantage of these market conditions and establish themselves as a leading edge logistics provider by differentiating themselves from competitors. To establish a credible reputation in the marketplace and remain competitive, many carriers have pursued a strategy of providing a variety of high quality customized services. As a result, some motor carriers have enhanced their competitive position and experienced considerable growth by expanding the number of services offered to customers (Crum and Allen, 1991).

BACKGROUND AND LITERATURE

The *Motor Carrier Act of 1980* was particularly troublesome for the Less-Than-Truckload (LTL) segment of the motor carrier industry (Corsi et al., 1991). The net impact of deregulation on the motor carrier industry has generally been positive (Winston et al., 1990). However, adjusting to the free market environment has been a fatal process for some carriers (LaLonde, 1984-1985). Bankruptcies have increased since deregulation (Harper and Johnson, 1987) and LTL motor carrier profits declined by approximately $5.3 billion in the ten years subsequent to deregulation (Corsi et al., 1991).

Prior to deregulation carriers had little incentive to expand service offerings to customers. As a result, most regulated carriers were solely transportation providers. Since deregulation, the number of participants in the LTL motor carrier industry has declined significantly (Fietler et al., 1998). In response to a "free" market environment characterized by high concentration levels, many carriers have been compelled to adjust their business strategy to survive.

As environmental conditions changed, carriers responded by making adjustments to their strategy in order to remain competitive. Strategy is a pattern of firm behavior which helps guide the future direction of the business (Hambrink, 1983). Porter asserts that there are three broad generic strategies which can be used to help achieve a competitive advantage (Porter, 1980). The three strategies are cost leadership, differentiation, and focus (Porter, 1980). While three strategies exist, he notes most successful companies typically implement one generic strategy in pure form instead of blending the strategies (Porter, 1980).

Cost leadership is striving to achieve lower costs than the competition. Focus is concentrating on a particular market segment. Differentiation is attempting to offer products or services that distinguish your offerings from the competition (Porter, 1980). The level of differentiation

achieved is the degree to which the product or service and its enhancements are perceived as unique (Hambrink, 1983a and 1983b).

Porter's three generic strategies have all been empirically tested. The results of several studies (Dess and Davis, 1980; Miller, 1987; Miller 1986; White, 1986) support the usefulness of Porter's strategy framework. While all three strategies are an important part of Porter's framework, differentiation is the generic strategy of primary interest in the current research.

There are many ways to achieve industry wide differentiation, including providing superior technology (Porter, 1980), offering unique features (Porter, 1980), and improving performance levels (Rothschild, 1984). Immediately after deregulation some carrier managers began bundling two or more logistics services together to provide the customer a unique combination of services. Bundling is taking place when two or more products or services are sold as a single package (Nagle, 1984). Many carrier managers felt they could differentiate their firm from competitors by offering customers a bundle of customized services at a competitive price.

Bundling can take many forms. However, the primary type of bundling examined in this research is mixed bundling. Mixed bundling is offering to provide each service separately or bundle the requested services together for resale (Paun, 1993). Immediately after deregulation, some LTL carriers began to practice mixed bundling. The researchers believe carriers attempted this strategy primarily for two reasons. First, they perceived the practice as constituting a unique service offering. Second, bundles are typically priced so the sum of the services packaged together is less than the price of purchasing each of the services separately (VanBuer, Venta, and Zydiak, 1997). Therefore, bundling might allow the carrier to offer a more competitive price to the marketplace.

In contrast to the lower prices often achieved by mixed bundling, Porter contends that as more resources are dedicated to achieving a differentiation strategy, the price of the service may need to be increased (Porter, 1980). Higher prices may reduce the ability of the firm to compete in a highly competitive marketplace (Porter, 1980). However, carriers successful in providing several unique competitive logistics services at a competitive price are often rewarded by customer loyalty. As the level of loyalty increases, competitors have a more difficult time convincing the customer to change providers, effectively reducing competition. Firms successfully differentiating their services from others may also notice customers becoming less sensitive to variables like price and length of contract.

Introducing competition to the motor carrier industry is a potential impetus for changes in strategy. The strategic re-evaluation undertaken by many carriers has attempted to address the issue of how to attract and retain customers and enhance profit. Recent studies have shown that pursuing a differentiation strategy is associated with improved carrier performance levels (Feitler et al., 1998). Some carriers believe one potential differentiation strategy for the LTL segment may be to expand and customize service offerings. While many service expansion opportunities exist, past studies indicate many firms tend to group transportation and warehousing services together because of the interface often required between the two services (Lieb and Randall, 1996; McGinnis et al., 1994; Turner, 1997). Additionally warehousing has been identified in prior research as a frequently outsourced logistics service (Holcomb, et al., 1997; Sink and Langley, 1997). Therefore, one relatively popular option for carriers is to augment LTL transportation by bundling it with customized warehousing services.

PURPOSE OF STUDY

The purpose of the current study is to gain insight into the evolution of the Class I LTL general freight motor carrier industry since deregulation. Specifically the research will examine how carriers have adjusted their strategic orientation since passage of the Motor

Carrier Act of 1980. This will be accomplished by examining: 1) the number of carriers offering warehousing services at a given point in time, 2) the types of warehousing services offered by carriers, 3) how each carrier achieved the service expansion, and 4) the growth rates of carriers bundling transportation and warehousing services together.

First, it is currently unclear what percentage of LTL carriers actually offer true warehouse services and which carriers simply claim to offer warehousing. The number of carriers augmenting transportation with warehousing will be identified. Second, there are many types of ancillary services (e.g., sorting or sequencing, price marking, bar coding and tracking, etc.) each carrier can offer in their warehousing division. The availability of these services and their level of customization will be investigated. Third, insight will be gained into how each carrier acquired the warehousing space needed for the service expansion. This includes examining the number of carriers acquiring warehouse space from each of three possible scenarios (internal, strategic alliance/partner, and external). Fourth, the timing of expansion will be examined by creating an innovation path. The path will illustrate the number of carriers offering warehousing services at a specific point in time. If significant growth levels are evident and numerous carriers now offer warehousing, one must question if offering an additional service like warehousing is truly a "unique" service offering. Offering multiple services may over time become a requirement for carriers wishing to remain competitive in the marketplace. As this becomes the case, service expansion may no longer be an avenue to a successful differentiation strategy.

Service bundling is not likely to be a successful differentiation strategy if several other carriers are also offering warehousing services. Therefore, one way to examine the potential effectiveness of bundling services together to achieve differentiation is to examine the number of competitors offering similar services at fixed points in time. Conceptually this is similar, but not identical to, examining the diffusion process for a "new" bundle of logistics services. Diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983).

The researchers treat carrier service bundling (motor carriage and warehousing) in a manner similar to a new service innovation. However, the results are not illustrated by constructing a diffusion curve and no specific decision variables are incorporated into the curve. A diffusion curve illustrates the total *volume* available in the market at fixed points in time (Bass, 1969). In contrast, the current research is interested in determining if bundling motor carriage and warehousing services together achieves differentiation by offering customers a unique bundle of services. The likelihood of achieving differentiation simply by bundling services together is low if several competitors are also successfully bundling transportation and warehousing services. Therefore, the current research constructs a graphical representation to examine the *number* of competitors (carriers) offering warehousing services a fixed points in time. This research will be consistent with past research (Oster, 1990) and allude to this type of graphical representation as an innovation path.

STUDY METHODOLOGY

Porter suggests successful differentiation typically requires additional company resources (Porter, 1980). For this reason the researchers chose to restrict the study to Class I LTL carriers. During the period of study a Ciass I LTL carrier was a carrier with annual revenues of $5 million or more. The researchers felt carriers with annual revenues of $5 million or more were the candidates most likely to have the resources available to achieve a successful expansion into warehousing.

A listing of all Class I LTL motor carriers was obtained from the National Motor Carrier Directory (1995). The Directory included information on the date each carrier was

established and gave the name, position, and telephone number of the primary contact person for the organization. The researchers captured carriers operating in both a regulated and deregulated environment by restricting the study to companies operating continuously from 1980 through the mid 1990's.

Initially we identified 94 Class I LTL motor carriers who had been in continuous existence from 1980 to 1995. Five of the 94 carriers specialized in express delivery and were subsequently dropped from further analysis. The researchers did not believe express delivery carriers were good subjects to examine because the types of services they offer are not comparable to most general freight carriers.

The remaining 89 carriers were contacted by telephone and asked to participate in the research. The initial phone conversation explained the goals of the research and sought the name of the organization representative most concerned with a possible service expansion into warehousing. The initial conversations identified eleven carriers who were no longer performing LTL transportation and fifteen who were no longer independent firms because of mergers or takeovers. Finally, two firms refused to participate. After initial contact, the researchers had a total of 61 Class I LTL carriers who agreed to participate and provide information on their operations (See Table 1).

The survey instrument was reviewed by executives of two large LTL carriers to make sure terminology was appropriate. After refinement of the survey was complete, the contact person for each of the 61 firms was sent a copy of the survey and interviewed in a subsequent telephone call. Interviews to complete the survey typically lasted 10 to 20 minutes. During the interview process several questions were asked about if and when the carrier expanded service offerings to include warehousing. For purposes of this research warehousing was defined as:

TABLE 1
DATA COLLECTION
AND SURVEY SAMPLE DESCRIPTION

Carriers contacted and asked to participate	89
Carriers no longer performing LTL carriage services	(11)
Carriers combined through merger or takeover	(15)
Carriers refusing to participate	(2)
Carriers participating in survey administration	61

> A business entity with space and services available to serve customers in the receiving, storing, putaway, inventory control, order picking, and shipping of the customer's goods for a designated period of time (Speh and Blomquist, 1988).

If the representative responded they did not offer any form of warehousing, only a short narrative section of the survey was administered. The purpose of the narrative section was to determine why the carrier elected to remain focused solely on transportation. In cases where the carrier did offer warehousing services to their customers, the entire survey was administered.

Included in the survey instrument were several additional questions designed to provide consistent criteria for carriers initially identifying themselves as a warehouse provider. A firm was classified as offering warehousing if it met at least one of the following tests.

1) The firm or division falls under the Uniform Warehouse Receipts Act (UWRA) and issues a warehouse receipt when goods are received.

2) The firm typically stored goods for 72 hours or more.

3) The firm billed customers separately (or itemized a combined transportation/warehouse bill) for warehousing services.

4) The firm priced warehousing services separately from transportation.

5) The warehouse facility is physically separate from any terminal facilities.

In rare cases it was difficult to determine whether the carriers were providing emergency terminal storage or longer-term warehousing. In these cases the dialog of the conversation was continued until an informed determination could be made on the type of storage services offered by the carrier. In most cases carriers who met the definition of warehousing had separate warehouse and terminal facilities.

SUMMARY RESULTS

The following section summarizes key findings from the research.

Most motor carriers (42 of 61 = 69%) surveyed were classified as providers of warehousing (See Table 2). Of the 61 carriers participating in the research almost half (28 of 61 = 46%) chose to provide warehousing services by acquiring space and labor internally. Interestingly, only 31% (19 of 61) of carriers surveyed indicated they do not offer any warehousing services to customers.

TABLE 2
CATEGORIZATION OF
LTL CARRIER EXPANSION BEHAVIOR

Firms indicating they did NOT expand into warehousing services	19 of 61 (31%)
Firms indicating they did expand into warehousing services	42 of 61 (69%)
Firms achieving expansion by providing the service internally	28 of 42 (66.7%)
Firms achieving the expansion by providing the service by some other means like a strategic alliance/partnership arrangement	14 of 42 (33.3%)

Over the last several years, experts have urged businesses to contract with specialists unless the activity in question is a core competence of the company. Companies can improve efficiency and productivity if they focus on their core competence or the activities that they do best. These types of activities are often provided internally and remain within the corporate walls if the company can do them more economically than outside specialists. Conversely, functions that are not considered to be core competencies are often outsourced. Interestingly, the current results indicate that roughly half of all Class I LTL carriers offering warehousing services have chosen to provide the additional services in-house. This treatment is consistent with recognizing the service as a core competence. It appears management personnel of many Class I LTL carriers consider warehousing to be within the realm of their core competence.

Seventy-six percent (32 of 42) of the time product stored in the warehouse remained there over 7 days and only 10% (4 of 42) of the time the product stayed less than 4 days. (See Table 3, Question #8). The results indicate motor carriers are making a clear distinction between cross-docking or temporary storage and legitimate warehousing services. Carriers are treating warehouse services as a separate logistics function. The two separate functions are then bundled together to furnish the customer multiple logistics services through one external provider.

Seventy-one percent (30 of 42) of carriers providing warehousing to customers identify the type of service they provide as being most similar to a contract warehouse situation (See Table 3). Another 24% (10 of 42) believe their services are most similar to a private warehouse facility. Only 2 of the 42 firms surveyed (5%) feel they are offering services most comparable to public warehousing facilities. Additionally over half the carriers (55%) cost and price warehousing services separately from transportation and another 38% consider warehousing costs in the overall price of services.

Warehousing appears to be a natural partner to trucking in the supply chain. Carriers typically pick up from, and deliver to, warehouses and

TABLE 3
CARRIER CHARACTERIZATION OF WAREHOUSING SERVICES

Question # 7: Characterize which of the following types of warehousing you consider your firm's services to be most similar to the majority of the time.	
Public	5%
Contract	71%
Private	24%
Question # 8: How long does product stored in your warehouse typically stay in the facility?	
Fewer than 4 days	10%
4 to 7 days	14%
Over 7 days	76%
Question # 9: Indicate which of the following statements best describes how you consider the cost of warehousing in the pricing of overall services.	
Warehouse cost is considered in the price of the overall service.	38%
Warehouse services are done primarily for customer service and the cost is not considered when pricing overall services.	7%
Warehouse service is costed and priced separately from motor carriage.	55%

often manage consolidation and cross-docking facilities. Warehousing is a major expense in the supply chain and shippers often use third parties to perform the function. Many LTL carriers already possess many of the materials handling and facility management skills which may easily transfer to warehouse management. Perhaps this is why many carriers participating in this research appear to view warehousing as a core competence. As a result, we expected shippers to be most comfortable with specialized and/or long-term warehousing. Therefore, it is not surprising that almost all of the carriers surveyed described their warehousing services to be most like a contract or private storage situation. They are attempting to deliver what the customer desires, and it is logical for most customers to prefer warehousing situations most similar to contract or private storage arrangements. Furthermore, the length of time product stays in storage indicates most customers are relatively comfortable giving warehousing duties to their carriers. Most likely this is because the carriers were already familiar with the operations of their customers.

While outsourcing has typically been studied from the perspective of the firm buying the service, the service suppliers also have important decisions to make. Carriers have to determine if it makes sense to invest capital and other resources in a related business. Should the carrier turn to a warehouse specialist, provide the service internally, or turn down the customer request and stick to transportation? If these results are any indication, most carriers do not see declining the customer's request for warehousing to be an option even though the service is a small contributor to total revenues. The primary decision faced by most carriers appears to be how to comply with their customer requests.

Further investigation was made into the types of value-added services offered in the warehouse (See Table 4). The researchers chose to inquire about seven different value-added services common to warehouse operations. Results reveal at least half the carriers surveyed responded positively when asked about offering each of the seven value-added services. Perhaps carriers feel successful pursuit of a differentiation strategy requires more that merely offering warehousing facilities. Many carriers are responding by claiming to offer customized value-added services within the warehouse. Logistics activities are being redistributed throughout the supply chain, and long-time participants are redefining their roles and responsibilities. Major customers are asking for more integrated services and lower costs. While third-party logistics companies may still have the broadest offerings, the current research indicates that carriers are also moving beyond their traditional functions to provide customers with a number of value-added services.

Not surprisingly several carriers indicated they would like to see warehousing become a significant portion of total profit for the carrier. However, the percent of total revenue provided by expansion into warehousing remains small in most cases (See Table 5). Only 17% (7 of 42) of carriers indicated total warehouse revenue exceeded 10% of total carrier revenue.

Internal vs. External Sourcing

Carriers were also asked about how they acquired the warehouse space necessary to complete the expansion into warehousing (See Table 5). The classification was determined based on the percentage of warehouse revenue gained from owner vs. independent facilities. If over 50% of a firm's warehouse revenue was from owned facilities, the carrier was placed in the "self-providing" (internal provider) category. Carriers not meeting the above criteria were classified as buyers of warehouse services. Buyers of warehouse services were subsequently categorized as either alliance participants or purchasers of warehouse space. This categorization was based on narrative information provided by each carrier during the telephone interview. For purposes of this study, a strategic alliance is the establishment of, and commitment to, a long-term interactive relationship where both parties benefit by sharing risks and resources (Ellram, 1991; Landeros and Monczka, 1989). Based primarily on this definition, carriers were considered to participate in an alliance if: 1) the relationship was characterized by a long-term commitment and 2) significant

TABLE 4
CARRIER RESPONSE TO KEY WAREHOUSING ISSUES

Survey item # / Item of discussion	% Yes	% No
14a) The warehouse provider offers price marking of shipments	69.0	31.0
14b) The warehouse provider offers specialized packaging/repackaging of shipments	69.0	31.0
14c) The warehouse provider offers sorting or sequencing of shipments	92.9	7.1
14d) The warehouse provider offers labeling of shipments	69.0	31.0
14e) The warehouse provider offers sub-assembly assistance on shipments	50.0	50.0
14f) The warehouse provider offers bar coding or tracking	73.8	26.2
14g) The warehouse provider offers order picking in odd lots vs. full package	78.6	21.4

TABLE 5
REVENUE PRODUCED (BY METHOD OF ACQUIRING WAREHOUSING SPACE)

Question # 15: Estimate the percentage of revenue provided by offering warehousing services.	
More than 50%	2%
More than 30% and up to 50%	5%
More than 10% and up to 30%	10%
Less than 10%	83%
Question # 17a (For carriers using internal expansion to acquire warehouse space): Estimate the percentage of warehousing revenue generated by offering warehousing services by providing the service *internally*.	
More than 85% and up to 100%	(20 of 28) = 71%
More than 70% and up to 85%	(5 of 28) = 18%
Less than 70%	(3 of 28) = 11%
Question # 17b (For carriers using a strategic alliance or partnership to acquire warehouse space): Estimate the percentage of warehousing revenue generated by offering warehousing services by providing the service through a *strategic alliance or partnership* arrangement.	
More than 85% and up to 100%	(8 of 11) = 73%
More than 70% and up to 85%	(2 of 11) = 18%
Less than 70%	(1 of 11) = 9%
Question # 17c (For carriers using a purchase agreement to acquire warehouse space): Estimate the percentage of warehousing revenue generted by offering warehousing services by *purchasing* the warehouse space.	
More than 85% and up to 100%	(2 of 3) = 67%
More than 70% and up to 85%	(1 of 3) = 33%
Less than 25	(0 of 3) = 0%

amounts of resources were shared between the two partners. Carriers not meeting this criteria were placed in the "purchase" category.

Of the 42 carriers providing warehousing services, two-thirds (28 of 42) acquired the needed warehouse space internally (See Table 2), again consistent with treating warehousing as a core competence. The remaining 14 carriers looked for outside assistance to acquire the needed warehouse space. Eleven of these entities formed an alliance or partnership with another company and only three purchased the warehouse space via an arms-length agreement.

Table 5 further analyzes warehousing revenues by examining revenue generated by each method (internal, strategic alliance/partnership, and external).

When carriers are faced with a make/buy decision for warehousing, they seem to operate much like their shipper customers. Larger carriers appear to be more likely to offer warehousing from their own buildings and with their own employees. Carriers appear to view warehousing as a core competence and tend to provide the service internally. This pattern appears consistent with past research (Maltz,

1994) which found as specialization increases in a private warehousing situation, providers opt to supply the service internally. Perhaps an increase in specialization infers a core competence and, as a result, is more likely to be handled internally. One could argue this may be surprising since carriers are likely to be very knowledgeable about the operations of any potential external warehouse provider. However, one could also argue this knowledge and expertise makes the carrier a difficult customer for any potential warehouse provider. Perhaps carriers are very discriminating customers when examining the warehousing operations of a potential partner and instead elect to provide the warehousing services themselves.

Growth in carrier expansion rates was also examined. Respondents were asked to estimate when the firm they represent first began to offer warehousing services. Table 6 summarizes the results. The results show consistent growth in the number of carriers providing warehousing since 1980 (See Column 2 of Table 6). The percent of carriers in the marketplace who have expanded services to provide warehousing has also experienced growth since deregulation (See Column 4 of Table 6). A graphical representation of the percent of carriers in the marketplace providing warehousing is also shown (See Figure 1). The graph illustrates the dramatic rise in warehouse service offerings by carriers. Carrier expansion into warehousing has experienced healthy growth since deregulation of the industry in 1980. However, the most dramatic growth in service expansion rates has occurred since 1990.

CONCLUSIONS

This research focuses on gaining insight into several key topics. First, carrier expansion habits are not well understood. This research examines the number of carriers expanding service offerings to include warehousing. Second, logistics service providers have many decisions to make about the types of services made available to customers. Specific services offered in the current marketplace are identified. Third, suppliers must explore how to best acquire the resources needed to achieve a service line expansion. Insight is gained into how various carriers acquire warehouse space. Fourth, growth rates of service bundling practices by carriers since deregulation is examined to see if bundling strategies are being adopted. This exploratory research should interest both shippers looking to reduce their supply base and carriers looking to augment market share.

Over two-thirds of the Class I LTL carriers that have survived deregulation appear to offer some form of warehousing services. LTL carriers appear to be increasing their roles in the supply chain which is likely to be good news for customers. As carriers continue to expand offerings, customers interested in obtaining multiple services from select carriers will have sufficient availability in the third-party logistics market.

MANAGERIAL IMPLICATIONS

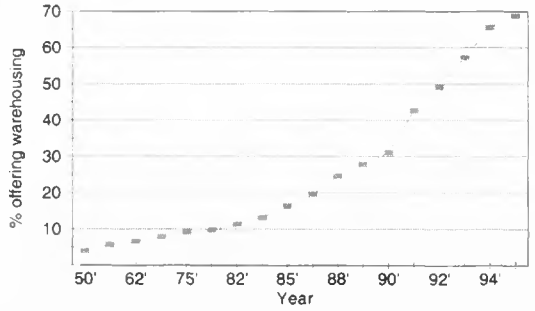
From the provider perspective, the results indicate it is unlikely that merely expanding service offerings to include an additional logistics function will allow the carrier to achieve differentiation. Successful differentiation is likely to require highly specialized, customized services uniquely tailored to the needs of each customer. However, offering highly specialized services to each customer may add to the complexity of carrier operations by requiring a deviation from the core competency of transportation. As a result, offering highly customized services may not always be advisable and needs to be investigated further.

Many types of value-added services are offered by carriers expanding into the warehousing market. In the period immediately subsequent to deregulation, many carriers began offering customized services to attract and retain customers. This was typically done by providing

TABLE 6
TIMING OF MOTOR CARRIER EXPANSION INTO WAREHOUSING SERVICES

Col # 1 Year	Col # 2 # Offering Warehousing	Col # 3 # of Firms in Existence	Col # 4 % of Firms Offering Warehousing
1950	1	26	1 of 26 = 3.84%
1956	2	35	2 of 35 = 5.71%
1962	3	45	3 of 45 = 6.67%
1967	4	51	4 of 51 = 7.84%
1975	5	55	5 of 55 = 9.09%
1980	6	61	6 of 61 = 9.84%
1982	7	61	7 of 61 = 11.48%
1984	8	61	8 of 61 = 13.11%
1985	10	61	10 of 61 = 16.40%
1987	12	61	12 of 61 = 19.67%
1988	15	61	15 of 61 = 24.60%
1989	17	61	17 of 61 = 27.87%
1990	19	61	19 of 61 = 31.15%
1991	26	61	26 of 61 = 42.62%
1992	30	61	30 of 61 = 49.18%
1993	35	61	35 of 61 = 57.38%
1994	40	61	40 of 61 = 65.57%
1995	42	61	42 of 61 = 68.85%

FIGURE 1
CLASS I LTL CARRIERS
EXPANSION INTO WAREHOUSING



customers a wider array of services (Pickett and Kletke, 1984; Rakowski, 1981) or expanding to include more innovative services (Harper, 1983, Harper, 1982). Results of the current research indicates these trends continue in the 1990's. Many logistics practitioners interviewed during the current study indicated they feel pressure from customers to offer multiple logistics services uniquely tailored to the needs of each customer. Carriers appear to be responding by making the commitment to expand offerings to customers and provide specific, customized services.

The sensitivity to current market trends may be an indication that carriers are moving toward a strategy of providing integrated logistics services to their customers. However, the intangible nature of services and diversity of customer demands make it very difficult to arrive at an optimal level of service offerings. As a result, many study participants indicated a difficulty determining which expanded service offerings to pursue to remain competitive, retain acceptable customer service levels, and maintain or increase market share.

How was the expansion achieved by carriers? It should be noted that 26% of the Class I LTL carriers offering warehousing services use a strategic alliance-type relationship with an external provider to achieve the service expansion. This number alone is significant enough to justify further consideration by carrier managers. However, the researchers suspect the number of carriers expanding by entering into a strategic alliance-type relationship with an external entity is much higher among smaller carriers. Past research (Hanna and Maltz, 1998) indicates carrier size is positively correlated with providing warehouse facilities internally.

Class I LTL carriers are larger carriers with significant resources. As a result, many of the carriers (66.7%) in the current study expanded by investing resources in internal assets and providing the additional service "in-house." However, in addition to Class I LTL carriers, hundreds of smaller carriers (Class II and III) feel the pressure to expand service offerings to customers. Many of these carriers may not have the resources to expand internally.

Many smaller carriers must examine other approaches to providing warehousing services to their customers. One alternative is to have the carrier act as lead integrated service provider. The lead provider (carrier) then determines the best way to provide the additional services required by their customer. Many smaller LTL carriers electing to pursue a differentiation strategy may find participation in a strategic alliance allows them the opportunity to provide additional value-added services.

Successful examples of beneficial and profitable strategic alliance-type relationships within the logistics industry can already be identified (Dyer et al., 1998, Lemmink et al., 1996; Rogers and Daugherty, 1995). A clear trend of pursuing a differentiation strategy by entering into a strategic alliance-type relationship with an external logistics provider is becoming apparent. However, before an alliance-type relationship can be successfully implemented, the partners must move away from treating business associates as adversaries; a dramatic contrast to past business practices which have traditionally viewed other entities as competitors.

Growth rates of service bundling practices are on the rise. Prior to deregulation less than 10% of carriers offered any type of warehousing services. However, since deregulation introduced competition into the market and forced carriers to compete for customers, service expansion into warehousing has exploded. Currently over two-thirds of all Class I LTL general freight motor carriers surveyed offer some form of warehousing services. While sufficient carrier growth into warehousing can be detected from 1980 to 1990, the most dramatic growth has occurred since 1990 (See Table 5 and Figure 1). Stiff competition from other carriers coupled with sophisticated and demanding customers has either enticed or forced carriers to expand offerings. Carriers are attempting to remain competitive in part by expanding services available and customizing those services.

Many shippers continue to reduce their supplier bases. Class I LTL carriers appear to be responding to the trend by offering more services and moving towards becoming integrated logistics providers. If carriers can remain sensitive to customer demands in the future, perhaps they will not only be able to provide multiple logistics services but will be able to accommodate customer demands throughout the entire supply chain. Understanding the current

conditions of the evolving marketplace is critical to improving shipper and carrier performance levels and warrants in-depth investigation.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

There are many possible extensions to the current research. This research focuses entirely on Class I LTL carriers expanding to provide warehousing. First, the population of Class I LTL motor carriers in business prior to 1980 and as of the end of 1995 could be expanded to include all Class I LTL carriers currently in operation. The research could also be expanded to include smaller LTL carriers or carriers in the TL segment of the industry.

Second, transportation and warehousing are just two of the many functions which could be studied. A similar methodology could be applied to studying carriers providing services other than warehousing (e.g., inventory control, order processing, materials handling, or packaging). Replication of this methodology to study the bundling of other services could help to better understand the strategic orientation of carriers.

Third, customers have many choices when outsourcing logistics functions. Many successful third-party logistics providers practice bundling and claim to customize services. Therefore, future research should not be limited to motor carriers expanding services. The scope should be expanded to include a diverse sample of external providers.

Fourth, this research focuses on United States firms. Companies in different regions must be sensitive to their operating environment if they are to remain competitive. A global examination of third-party logistics service providers could contribute additional insight into current global outsourcing practices.

Fifth, relatively little research has focused on the provider portion of logistics services. Most research in the third-party logistics market focuses on demand for services. As a result, supply-side research into logistics outsourcing is critically needed.

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THE RELATIONSHIP BETWEEN THE FUNCTIONAL ORIENTATION OF SENIOR MANAGERS AND SERVICE QUALITY IN LTL MOTOR CARRIERS

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ABSTRACT

This study utilizes data envelopment analysis to examine the relationship between the functional heterogeneity of senior LTL motor carrier managers' departmental positions and the relative efficiency of their companies in the production of quality customer service. Three measures from the *Quest for Quality* annual survey are utilized to measure customer satisfaction: on-time performance, value, and customer service.

It is shown that data envelopment analysis can be used to assist LTL motor carriers in benchmarking the configuration of their managerial hierarchies against their peers in order to achieve the goal of customer satisfaction. The results of the present study confirm that senior level managers in operations and marketing-oriented functions have become more prevalent in the current deregulated operating environment. Furthermore, the results suggest that an optimal balance between senior level managers in market-oriented functions and those in operations-oriented functions does exist when the targeted objective is customer satisfaction. The study also demonstrates that most LTL motor carriers were relatively inefficient in their configuration of these senior level managers.

INTRODUCTION

Since the enactment of the Motor Carrier Act of 1980, researchers have often attempted to ascertain the determinants of the freight carrier selection process. This issue has assumed greater urgency of late as reflected by the results of a joint study by the University of Tennessee, Mercer Management Consulting, and Ernst & Young, LLP (Holcomb and Manrodt, 2000) which found that shippers in the study had made a conscious effort to reduce the number of carriers

used. Many studies have examined the overall quality of service and its relationship to costs. Specifically, McGinnis (1990) reviewed empirical studies done during the 1970's and 1980's to address the relative importance of service and cost as determinants of the transportation choice decision and whether this choice changed after deregulation. It was found for the periods before and after deregulation that cost was a major factor only after service objectives were met.[1] Taylor and Meinert (2000) state that even though low cost was important, it was not the only concern of shippers. Lambert, et al. (1993) also found that greater emphasis on the quality of service delivered was more important to shippers than low rates. D'Aveni (1995) has noted that as competition increases, the value (ratio of quality to cost) offered by firms causes customers to move toward the firm offering the higher value at a given price. Holcomb and Manrodt (2000) further found that carriers must better understand the needs of their customers in order to provide this greater value. In order to offer low prices, companies continuously search for ways to decrease operating costs without sacrificing the quality their customers expect. Liu (1993) developed an equilibrium model taking the service quality levels as given with the carriers competing by setting rates. It was found that only a small number of competing carriers could coexist in a market of intense competition where shippers demand high service quality yet want to control costs. Additionally, Allen and Liu (1995) found that excluding service quality measures from the cost estimation functions underestimates scale economies.

Wisner and Lewis (1996) examined the quality issue from the carrier's perspective in a survey of transportation company members of the American Society of Transportation and Logistics. They found that quality of service is also a concern of the carriers. The survey found that many companies have implemented formal quality improvement programs and appear to be committed to quality improvement.

Crosby (1979) defines quality as "conformance to requirements." The problem with this definition is that the

> . . . customer often perceives the quality of the intangible service differently than the provider does. It is this difference in perception of service that creates polarization in defining and satisfying transportation customers . . . (Crosby, 1979, p. 63).

Parasuraman, et al. (1985) further state that consumers use their expectations, coupled with perception of performance, to measure the quality of service delivered.

Many variables have been used to measure quality. In a review of the marketing literature, Parasuraman, et al. (1985) provide some insight into service quality determinants. They found the following determinants of service quality: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding of the customer and tangible measures. The tangible measures include physical facilities, equipment and per-sonnel. Lambert, et al. (1993) found that 16 of the 18 variables rated most important by their survey respondents were service related. The four variables ranked highest were quality of dispatch personnel, on-time pickups, on-time deliveries, and competitive rates. Allen and Liu (1995) used a service index and convenience index from *Distribution* magazine's annual "Quest for Quality Survey." Liu (1993) used transit time as a proxy for service quality. Chow and Poist (1984) used seven categories of overall service quality in their survey of transportation choice decision makers. They found that a significant number of decision makers do not record the carrier attributes which are rated as highly important in the carrier selection decision. However, the factors that were recorded, either formally or informally, related to rates, claims, transit time, equipment, and operations.

McGinnis (1989) identified the following five service variables: reliability, transit time, specific shipper needs, over, short, or damaged freight, and specific carrier characteristics.

This study investigates the relationship between the level of customer-perceived quality and the functional orientation of senior managers in LTL companies. Early work done by Dearborn and Simon (1958) is extensively cited in the literature as providing evidence that managerial cognition is influenced by their functional experience. A group of 23 executives, all employed by the same large manufacturing firm and enrolled in a company sponsored executive training program were asked to read a standard policy case. Dearborn and Simon collected brief statements from these executives about the most important problem they perceived in the case. An analysis of these statements allowed them to relate the function from which a particular manager came and the type of problem identified. From this they concluded that executives are more focused on those items that specifically relate to their job functions.

Several criticisms can be directed at this study. The sample size was small and all the managers were attending an executive training program. Such programs tend to stress the importance of developing general management perspectives. Additionally, all participants were from the same firm. Most notably, the instructions given to the participants were interpreted inconsistently. They were asked to note the most important problem, but, in fact, Dearborn and Simon note that several listed up to three problems.

Walsh (1988) sought to extend the work of Dearborn and Simon. Utilizing the notion that managers' belief structures are derived from their experience and that past functional, organizational, and industry experiences may be influential in shaping belief structures, he sought to study the effect of a manager's belief structure on the problem identification process. In his study Walsh used 121 mid-career managers who were enrolled in a two-year, part-time executive masters degree program at a large university. In the first part of the experiment, each manager was given a randomly ordered deck of 50 cards. Each card contained a factor broadly related to the success of an organization. Walsh used three main functional groupings in the study. These were human relations, accounting/finance and marketing. The managers were asked to sort the cards into piles of related factors and to rank the importance of these piles. In the second part of the experiment, the managers were given the three-page case history and they were asked to identify the problem or problems facing the company. This case was deliberately designed to contain an ill-structured situation with associated issues that spanned a number of functional domains.

The results of both parts of the experiment stand in interesting contrast to the Dearborn and Simon study. Walsh found that 49 percent of the managers in his sample had a "generalist" orientation. However, as with the Dearborn and Simon study, several problems have been noted. Some of the factors presented on the cards, which were purportedly related to causing organization success, could also be regarded as measures of success. Additionally, the list of factors seemed to contain many factors that could not clearly be associated with any particular function. Finally, as with the Dearborn and Simon study, the sample was drawn from an executive training-type program.

A study undertaken by Nystrom (1991) utilized a sample of 73 alumni of an executive MBA program. Thus, there was the inherent limitation noted above with regard to the two earlier studies. Using a framework similar to Dess and Davis (1984), Nystrom derived a list of generic competitive methods based on Porter's competitive strategies. Participants were asked to rate how important particular competitive methods were to their company's overall strategy. The results of this experiment were twofold. First, managers of production and finance departments tended to perceive competitive methods associated with a low-cost strategy as being more important than their counterparts in marketing and R&D departments. Second, managers of

marketing and R&D departments tended to perceive those competitive methods associated with a product-differentiation strategy as being more important than their counterparts in production and finance departments.

Bowman and Daniels (1995) undertook a study utilizing a more representative sample of managers (not based on an association with an executive development program) and a larger sample size. Additionally, they did not use the case-based approach of the Dearborn and Simon and Walsh studies. The sample used in this study was 319 managers from 42 different strategic business units in the United Kingdom. Bowman and Daniels, utilizing the methodology employed by Nystrom, found several statistically significant results. First, production/operations managers rated cost control priorities higher than managers in finance/accounting, sales/marketing, or general management. Second, sales/marketing managers rated differentiation priorities higher than all other managers. Third, finance/accounting and sales/marketing managers rated cost control priorities lower than the other management groups. Finally, finance/accounting and production/operations managers rated differentiation priorities *lower* than other managers.

Corsi, Grimm and Feitler (1992) examine the impact of deregulation on LTL motor carriers with regard to size, structure, and organization. Of particular relevance to the present study is their hypothesis that the deregulated environment is one where managerial skills relating to marketing and product development are perceived as having greater value than those focused on accounting and production. Marketing includes issues of pricing and sales. They utilized a matched sample of 96 LTL motor carriers for 1977 and 1987. They examined the job titles of senior managers and identified eleven functional managerial categories. These categories were grouped into the three subgroups of market-oriented, regulatory-oriented, and other functions. Job titles included in the market-oriented category were marketing, rates/tariffs, and finance/comptroller while those in the regulatory-oriented category were law, claims, and traffic management. All other job titles were included in the "other" category. Their results suggest a statistically significant change in the distribution of senior managers among the three subgroups with the number of managers in market-oriented functions increasing at the expense of regulatory-oriented functions.

DESIGN OF THE STUDY

This study utilizes the annual *Quest for Quality* survey which is the most extensive research study conducted to evaluate and measure transportation providers in the logistics industry. It also attempts to determine the relevant criteria for customers in their selection of a particular type of carrier. Results from the last several years of surveys have strongly indicated that the three most important attributes in evaluating LTL carriers are on-time performance, value and customer service. The highest rated critical category was on-time performance, being seen as even more important than price. Furthermore, when LTL carriers arrive on schedule, shipping operations run smoothly and there are fewer backups at loading docks.

Such performance benchmarks have become particularly important for LTLs in the last few years. Comments provided by respondents to the survey over the period 1993 to 1997 suggest a trend on the part of LTL buyers to reduce the number of carriers with whom they have working relationships. This places a greater emphasis on monitoring contracts and service and switching carriers if necessary.

Clearly, the value-added activities noted above have become strategic priorities for LTL carriers. At the same time, the prioritization of the activities is a function of the perceptions of top-level managers. In fact, it has been suggested that the composition of the functional orientation of senior managers should be actively managed (Hambrick and Mason, 1984; Abernathy, 1980). In this spirit, this study investigates the

relationship between the functional orientation of top level managers and the ability of LTL carriers to achieve relatively superior performance with regard to the three measures of on-time performance, value and customer service.

The current study uses data envelopment analysis (DEA) to investigate the relationship between the functional heterogeneity of senior LTL motor carrier managers' departmental positions and the relative efficiency of their companies in the production of quality customer service. Drawing upon the results of the previous studies, it is argued that the functional background of senior managers will influence the motor carriers' overall choice of competitive strategies as defined by Porter. Thus, the results of the analysis will also suggest whether or not a motor carrier's choices with regard to competitive strategies are aligned with their ability to provide quality customer service. A statistical analysis is also undertaken to examine the relationship between a motor carrier's relative efficiency with regard to the production of customer service and profitability.

The next section describes the data used in the analysis. An explanation of the DEA methodology follows along with a discussion and evaluation of the results.

DATA COLLECTION

Two years of data are included in this study: 1993 and 1997. These years represent end-points of a five-year period with the most complete set of necessary data. The carriers used in this study are those with complete information regarding the functional affiliations of senior managers. This information is obtained from the *Official Motor Carrier Directory* for the years 1993 and 1997. The quality of customer service scores is obtained from the *Quest for Quality* surveys. A final sample of 32 LTL motor carriers (64 observations) for the years 1993 and 1997 is obtained that meets the above criteria.

The input data variables used in this study relate to the functional categories of senior managers and is similar to those of the Corsi, Grimm, and Feitler (1992) study: financial, maintenance or safety, marketing, and operations. The financial-oriented category includes such activity titles as rates/tariffs, finance, and comptroller. The marketing-oriented group includes marketing, sales and customer relations. The maintenance/ safety category includes maintenance and safety titles. The operations-oriented category includes operations and traffic management. All other activity titles are placed in the "other" category and are not used in this study. The percentages of total senior managers for each of the four categories are the input variables. Panel A of Table 1 lists descriptive statistics for the input variables. The average percent of senior managers with a maintenance or safety title is lowest (8%). In fact, 26 of the 64 observations (41%) employ no senior managers with maintenance or safety titles. On average, the companies employ more senior managers with operation-oriented titles than any other title (22%).

The outputs in this study are the customer service measures of three dimensions of quality from the *Quest for Quality* survey: on-time performance, value, and customer service. Carriers are rated on a three-point scale (3 = outstanding; 2 = average; 1= poor) that is then averaged and reported in the survey results. The on-time performance variable measures a carrier's performance with regard to pickup and delivery, consistent and dependable schedules and transit times, and equipment availability. The value variable measures a carrier's performance with regard to the competitiveness of rates with other carriers offering the same service, the commensurability of pricing to the service level required by the customer, and the simplicity of rates. Customer service measures a carrier's performance with regard to the prompt settlement of claims, the ability to trace and expedite shipments, and the prompt and courteous solution of problems. Minimum values for on-time performance and customer service

TABLE 1
DESCRIPTIVE STATISTICS FOR DATA VARIABLES

PANEL A - INPUT VARIABLES[a]

	Financial Titles	Maintenance/ Safety Titles	Marketing Titles	Operations Titles
Average	15.4%	8.0%	20.9%	22.2%
Minimum	0.0	0.0	0.0	0.0
Maximum	40.0	22.2	50.0	50.0
Median	14.3	7.4	20.0	20.0

PANEL B - OUTPUT VARIABLES[b]

	On-Time Performance	Value	Customer Service
Average	2.257	2.129	2.161
Minimum	1.880	1.870	1.790
Maximum	2.600	2.440	2.530
Median	2.260	2.130	2.155

[a]Data are obtained from the *Official Motor Carrier Directory*. These data are accumulated over the two-year period of the study.
[b]Data are obtained from *Distribution* magazine's annual "Quest for Quality Survey." The ratings are based on a three-point scale (3 = outstanding; 2 = average; 1 = poor).

are attributable to DiSalvo-1993, while Fredrickson Motor Express-1997 received the minimum score for the value variable. American Freightways-1993 is tied with Wilson Trucking-1997 for the maximum value for on-time performance. Wilson Trucking-1997 also has the maximum values for customer service. Pitt Ohio Express-1993 earns the maximum for the value variable.

DATA ENVELOPMENT ANALYSIS

The methodology employed in this study is data envelopment analysis (DEA). This methodology is used to compare the relative efficiencies of decision-making units (DMUs). The criterion for efficiency is that used in traditional microeconomic analysis with regard to production plans. A production plan is efficient if there is no way to produce more output with the same inputs or to produce the same output with fewer inputs.

DEA differs from standard econometric methodology in its implementation of the efficiency criteria noted above. The traditional parametric production function uses a specific pre-defined functional form that is assumed to apply to each DMU. DEA is a nonparametric technique that makes no assumptions about the form of the production function and instead optimizes the performance measure of each DMU. An empirical best practice production frontier is thus estimated from the actual, observed inputs and outputs of individual DMUs. This frontier replicates the behavior of individual units rather than that of the average sample estimate of parametric production functions. A DMU is therefore considered efficient when comparisons with other units indicate no inefficiency in the utilization of inputs and outputs, as measured by its position relative to the efficient production frontier. In other words, the objective of DEA is to minimize total waste in both the inputs and

the outputs. Another important aspect of DEA is that it allows the efficiency scores to be independent of the units of measurement for the data, i.e., units-invariant.

Three sets of information are used in the analyses: input, output, and descriptive measures. Input measures represent minimizing goals, such as minimizing the number of marketing executives and/or minimizing the number of maintenance executives. Output measures represent maximizing goals such as maximizing customer service. Descriptive measures represent variables used to further discriminate between efficient and non-efficient observations.

The analysis in this study employs the input oriented model since the objective of this research is to determine whether the functional orientation of managers affects the quality of customer service. In the case of the input oriented model, one set of variables, inputs, takes priority over the output variables. This model seeks to minimize the inputs utilized. The implicit underlying premise in such an orientation is that the primary objective of the motor carrier under evaluation is to gain efficiency by reducing excess input utilization while continuing to operate with the current technology mix (reflected in actual input ratios). A measure of efficiency for the input oriented model as defined in Charnes et al. (1978) is t'. This efficiency measure is the multiple of the input vector that would yield the current level of output. A most desirable aspect of the input-oriented model is that, because it measures inefficiency in terms of proportional changes of inputs, it allows a motor carrier to be evaluated with respect to a best practice motor carrier that is most similar to it in terms of input mix. It should be noted that an efficient observation will have an efficiency measure, t', of 1.000.

The efficiency measure, t', conveys information with regard to managerial policy. Consider the following case. Suppose Motor Carrier A has a peer group of motor carriers that have comparatively efficient percent of senior managers with specific functional titles allowing them to achieve the levels of output of Motor Carrier A more efficiently. If t' is very small, then the mix of senior managers of Motor Carrier A is really off the mark and attention should be focused on shifting the input senior manager mix. If, on the other hand, t' is close to 1.000, then the motor carrier could remain with its current senior manager mix and achieve the same levels of output with a small scaling down. Thus, utilization of the input oriented model allows the researcher to develop assessment measures of inefficiency and to also evaluate the efficacy of managerial strategies.

RESULTS

Table 2 presents a list of the values for the input oriented efficiency score, t, for each observation, with summary statistics shown in Table 3. As shown in Panel A of Table 3, the overall values for t range from 0.288 to 1.000 (efficient). The minimum value is attributable to G.I. Trucking-1993. A value of 0.288 for t implies that the carrier in question could have produced its current level of customer perceived quality and, at the same time, proportionally reduced all inputs in the process by 71.2 percent. Only two companies are considered efficient for both years: American Freightways, and Ward Trucking. Eighteen companies show an increase in efficiency from 1993 to 1997 with ten of those companies improving their input mix over the period to attain an efficiency measure of 1.000 in 1997. Twelve companies show a decrease in efficiency with eight companies actually starting in 1993 with an efficiency measure of 1.000 and then suffering a decrease in relative efficiency.

TABLE 2
EFFICIENCY SCORES[a]

Carrier	Year	$\acute{\iota}$
AAA Cooper Transportation	**1993**	**1.000**
AAA Cooper Transportation	1997	0.591
ABF Freight Systems	1993	0.510
ABF Freight Systems	1997	0.578
American Freightways	**1993**	**1.000**
American Freightways	**1997**	**1.000**
ANR Advance	1993	0.380
ANR Advance	1997	0.469
A-P-A Transport	1993	0.818
A-P-A Transport	**1997**	**1.000**
Averitt Express	**1993**	**1.000**
Averitt Express	1997	0.510
Con-Way Central Express	1993	0.934
Con-Way Central Express	1997	0.745
Con-Way Western Express	1993	0.603
Con-Way Western Express	**1997**	**1.000**
Di Salvo	1993	0.843
Di Salvo	**1997**	**1.000**
Estes Express	1993	0.472
Estes Express	1997	0.567
Fredrickson Motor Express	**1993**	**1.000**
Fredrickson Motor Express	1997	0.368
G.I. Trucking	1993	0.288
G.I. Trucking	1997	0.335
Lynden Transport	1993	0.463
Lynden Transport	**1997**	**1.000**
Motor Cargo	1993	0.570
Motor Cargo	1997	0.626
NationsWay (NW Transport)	1993	0.675
NationsWay (NW Transport)	1997	0.476
New England Motor Freight	1993	0.972
New England Motor Freight	**1997**	**1.000**
Old Dominion Freight Lines	1993	0.370
Old Dominion Freight Lines	1997	0.480
Overnite Transportation	1993	0.688
Overnite Transportation	1997	0.743
Pitt Ohio Express	**1993**	**1.000**
Pitt Ohio Express	1997	0.623
Preston Trucking Co.	**1993**	**1.000**
Preston Trucking Co.	1997	0.598
Roadway Express	1993	0.716
Roadway Express	1997	0.631
Saia Motor Freight	**1993**	**1.000**
Saia Motor Freight	1997	0.608
Southeastern Freight Lines	1993	0.812
Southeastern Freight Lines	**1997**	**1.000**
USF Bestway (TNT Bestway)	1993	0.601
USF Bestway (TNT Bestway)	1997	0.477
USF Holland (TNT Holland Motor	1993	0.787
USF Holland (TNT Holland	**1997**	**1.000**
USF Red Star	**1993**	**1.000**
USF Red Star	1997	0.549
USF Reddaway (TNT Reddaway)	1993	0.873
USF Reddaway (TNT	**1997**	**1.000**
Viking Freight System	1993	0.896
Viking Freight System	**1997**	**1.000**
Ward Trucking	**1993**	**1.000**
Ward Trucking	**1997**	**1.000**
Watkins Motor Lines	**1993**	**1.000**
Watkins Motor Lines	1997	0.947
Wilson Trucking	1993	0.652
Wilson Trucking	**1997**	**1.000**
Yellow Freight System	1993	0.811
Yellow Freight System	1997	0.832

[a] $\acute{\iota}$ is the input-oriented efficiency score. A score of 1.000 means that the observation has no inefficiency. Efficient observations are shown in bold.

TABLE 3
SUMMARY STATISTICS FOR ι'

PANEL A
ALL OBSERVATIONS

	ι'^{a}
Average	0.758
Minimum	0.288
Maximum	1.000
Median	0.800

PANEL B
INEFFICIENT OBSERVATIONS ONLY

	ι'^{a}
Average	0.631
Minimum	0.288
Maximum	0.972
Median	0.606

[a] ι' is the input-oriented efficiency score. A score of 1.000 means that the observation has no inefficiency.

The number of observations with an efficiency score of 1.000 is 22, leaving the remaining 42 observations as relatively inefficient. Although 42 observations are not considered efficient, it is important to consider the range of values within this group. Panel B of Table 3 presents summary information for ι for the inefficient observations only. As previously stated, G.I. Trucking-1993 has the lowest value for ι (0.288); New England Motor Freight-1993 attains the maximum value of 0.972. The average value for ι is 0.631. An examination of the quartiles for ι reveals that the second quartile ranges from 0.510 to 0.603; the third quartile ranges from 0.608 to 0.787; and the fourth quartile ranges from 0.812 to 0.972. Some of the observations in the fourth quartile may be considered somewhat efficient in terms of having managers with the appropriate functional backgrounds necessary to produce high quality customer service. These results suggest that some companies correctly perceived the optimal training background needed to provide the level of service quality demanded by their customers.

Table 4 displays the amount of inefficiency for all observations and all variables. The amount of inefficiency compares the actual value with a projected efficient value for the specific observation. A value of 0.000 for the amount of inefficiency means that the actual input value equals the optimally calculated projected value. Input inefficiencies carry a negative sign indicating the necessary reduction for efficient operation. An examination of the amount of inefficiency for the individual input variables can be used to explain the observed range of values for ι. For all variables, the efficient observations have the projected value equal to the actual value so the following will discuss only the results for the inefficient observations.

Three of the 42 inefficient observations operate with the actual percent of managers with financial backgrounds equal to the projected percent; 5 (2) observations have the actual equal to the optimally projected percent of marketing (operations) background; and 14 observations have the actual equal to the optimally projected percent of maintenance/safety title.

Table 5 presents summary statistics for the amount of the input inefficiencies for the inefficient observations only. Throughout the period of the study, the average level of inefficiency is 0.067 for the financial title, 0.032 for maintenance/safety, 0.077 for marketing title, and 0.091 for operations. All titles achieve the minimum amount of inefficiency (0.000). The highest value for the amount of inefficiency (-0.286) is denoted by a negative sign and occurs in the operations title. In examining the number of times that each title has the largest amount of inefficiency, it is noted that 43% of the observations are for the operations title, 28% are for the marketing title, 19% are for the financial title, and 10% are for the maintenance/safety title. This suggests that observations with managers having marketing backgrounds are

TABLE 4
AMOUNT OF INEFFICIENCY [a]

Company	Year	Financial Titles	Maintenance/ Safety Titles	Marketing Titles	Operations Titles
AAA Cooper Transportation	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
AAA Cooper Transportation	1997	-0.068	0.000	-0.068	-0.116
ABF Freight Systems	1993	-0.071	-0.036	-0.143	-0.107
ABF Freight Systems	1997	-0.032	-0.043	-0.159	-0.064
American Freightways	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
American Freightways	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
ANR Advance	1993	-0.171	-0.122	-0.171	-0.086
ANR Advance	1997	-0.083	0.000	-0.167	-0.083
A-P-A Transport	1993	-0.017	0.000	-0.033	-0.017
A-P-A Transport	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Averitt Express	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Averitt Express	1997	-0.084	0.000	-0.126	-0.186
Con-Way Central Express	1993	-0.111	0.000	0.000	0.000
Con-Way Central Express	1997	-0.025	-0.050	-0.050	-0.050
Con-Way Western Express	1993	-0.099	-0.074	-0.049	-0.049
Con-Way Western Express	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Di Salvo	1993	-0.016	-0.016	-0.008	-0.040
Di Salvo	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Estes Express	1993	-0.115	-0.058	-0.173	-0.058
Estes Express	1997	-0.088	-0.104	-0.071	-0.053
Fredrickson Motor Express	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Fredrickson Motor Express	1997	-0.050	0.000	0.000	0.000
G.I. Trucking	1993	-0.252	0.000	-0.126	-0.163
G.I. Trucking	1997	-0.245	0.000	-0.122	-0.152
Lynden Transport	1993	-0.086	-0.137	-0.173	-0.086
Lynden Transport	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Motor Cargo	1993	-0.105	-0.035	-0.035	-0.070
Motor Cargo	1997	-0.062	-0.031	-0.062	-0.062
NationsWay (NW Transport)	1993	-0.036	-0.036	-0.071	-0.071
NationsWay (NW Transport)	1997	-0.149	-0.037	-0.074	-0.074
New England Motor Freight	1993	0.000	0.000	0.000	-0.040
New England Motor Freight	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Old Dominion Freight Lines	1993	-0.172	0.000	-0.103	-0.208
Old Dominion Freight Lines	1997	-0.047	0.000	-0.140	-0.125
Overnite Transportation	1993	-0.043	-0.034	-0.043	-0.119
Overnite Transportation	1997	-0.010	0.000	-0.005	-0.286
Pitt Ohio Express	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Pitt Ohio Express	1997	-0.047	-0.047	-0.140	-0.047
Preston Trucking Co.	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Preston Trucking Co.	1997	-0.044	-0.122	-0.087	-0.087
Roadway Express	1993	-0.032	-0.016	-0.064	-0.112
Roadway Express	1997	-0.044	-0.022	-0.087	-0.109
Saia Motor Freight	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Saia Motor Freight	1997	-0.049	-0.024	-0.097	-0.097
Southeastern Freight Lines	1993	-0.009	-0.018	-0.035	-0.166
Southeastern Freight Lines	**1997**	**0.000**	**0.000**	**0.000**	**0.000**

Table 4
(continued)

Company	Year	Financial Titles	Maintenance/ Safety Titles	Marketing Titles	Operations Titles
USF Bestway (TNT Bestway)	1993	-0.065	-0.081	-0.065	-0.065
USF Bestway (TNT Bestway)	1997	-0.094	-0.047	-0.141	-0.141
USF Holland (TNT Holland Motor Express)	1993	-0.019	-0.043	-0.039	-0.104
USF Holland (TNT Holland Motor Express)	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
USF Red Star	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
USF Red Star	1997	-0.101	0.000	-0.101	-0.133
USF Reddaway (TNT Reddaway)	1993	-0.016	-0.016	-0.016	-0.066
USF Reddaway (TNT Reddaway)	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Viking Freight System	1993	0.000	-0.051	-0.015	-0.005
Viking Freight System	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Ward Trucking	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Ward Trucking	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Watkins Motor Lines	**1993**	**0.000**	**0.000**	**0.000**	**0.000**
Watkins Motor Lines	1997	-0.002	-0.002	-0.005	-0.111
Wilson Trucking	1993	-0.022	-0.022	-0.132	-0.119
Wilson Trucking	**1997**	**0.000**	**0.000**	**0.000**	**0.000**
Yellow Freight System	1993	-0.017	-0.017	-0.034	-0.043
Yellow Freight System	1997	-0.023	-0.011	-0.011	-0.068

[a]Amount of inefficiency is calculated by subtracting the actual value from the projected efficient value. Efficient observations are shown in bold. The number of inefficient observations is 42.

TABLE 5
SUMMARY STATISTICS FOR THE AMOUNT OF INEFFICIENCY FOR INEFFICIENT OBSERVATIONS ONLY

	Financial Titles[a]	Maintenance/Safety Titles[a]	Marketing Titles[a]	Operations Titles[a]
Average	-0.067	-0.032	-0.077	-0.091
Maximum	-0.252	-0.137	-0.173	-0.286
Minimum	0.000	0.000	0.000	0.000
Median	-0.048	-0.022	-0.069	-0.084

[a]The amount of inefficiency is calculated by subtracting the actual value from the projected efficient value. The number of inefficient observations is 42.

better able to strategically position their company to provide high quality customer service than those with operations titles.

Table 6 contains information regarding the Wilcoxon test performed to determine whether the efficient observations differ from the ineffi-

TABLE 6
LINEAR RANK STATISTICS
EFFICIENT VS INEFFICIENT
MOTOR CARRIERS

Panel A – Ton-Miles [a]

	N[b]	MEAN	H_0: Mean (Inefficient) ≥ Mean (Efficient)
Inefficient	30	2,414,820,519	
Efficient	15	736,479,973	
WILCOXON TEST			Prob > |Z| = 0.043

Panel B – Operating Ratio [a]

	N[b]	MEAN	H_0: Mean (Inefficient) ≤ Mean (Efficient)
Inefficient	35	0.942	
Efficient	17	0.928	
WILCOXON TEST			Prob > |Z| = 0.155

[a] Data are obtained from the American Trucking Association's financial database, *Financial and Operating Statistics*. These data are accumulated over the two-year period of the study.

[b] Complete data was not available for all observations.

cient observations in terms of size, measured by ton-miles driven, and profitability, measured by the operating ratio. It should be noted that not all observations are included in this analysis because the financial information included in the American Trucking Association's *Financial and Operating Statistics* database for the years 1993 and 1997 is not complete. There are no legal requirements for the carriers to file this information; so many companies do not include all requested data. The average ton-miles operated by the inefficient carriers appear to be much greater than that of the efficient carriers. However, the null hypothesis that the mean number of ton-miles operated for the inefficient observations equals or exceeds that of the efficient observations is rejected at a level of 0.043. This suggests that efficient observations are the larger carriers. A similar test was conducted for the operating ratio. The average operating ratio for the inefficient observations is 0.942 while for the efficient observations it is 0.928. The null hypothesis that the mean operating ratio for the inefficient observations is lower than that of the efficient observations cannot be rejected. There is no perceived difference in the profitability of the two groups.

The inefficient observations are further divided into the larger observations, defined as those with ton-miles exceeding the sample's average ton-miles. Ten observations (out of 42 inefficient observations) are in this group. 75% of those observations show the operating title as the variable with the largest amount of inefficiency, while there are none for the financial or maintenance/safety titles. The observations with an operating ratio below that of the sample's average ratio (more profitable) is fifteen out of 42. In this case, the operations title appears most often (56% of the time) for the largest amount of inefficiency and the financial title appears least often (2%). The maintenance/safety title appears 13% of the time and the marketing title occurs in 29% of the observations. This is consistent with the overall examination of the 42 inefficient observations and suggests that even though the larger and more profitable observations are those with inefficiency in the number of operations managers, a decrease in the number of operations managers could lead to increased customer perceived satisfaction. This also is true for the number of marketing managers.

MANAGERIAL IMPLICATIONS

The literature suggests that, even though senior managers are expected to have a generalist's view of their organization, in fact, each typically brings an orientation that has developed from experience and training in some primary functional area. Indeed, Bayster and Ford (2000) find that those in different functional classifications make significantly different decisions. The Corsi, Grimm and Feitler study (1992) suggests that the deregulated environment for LTL motor carriers is one where those managerial skills relating to marketing and product development are perceived as having

greater value than those focused on accounting and production. This study suggests that motor carrier managerial hierarchies can do more than simply recognize this "trending" phenomenon. Specifically, the portfolio of functional expertise of senior managers should be an important aspect of the company's business strategy.

Data envelopment analysis is used to provide a quantitative framework that enables senior managers to benchmark this strategic human resource activity and to specifically identify relative inefficiencies in the existing hierarchal structure of LTL motor carriers. The manner in which the LTL configures its senior level of managers around functional categories will have a variety of strategic impacts. Managers with a marketing orientation will focus on product innovation, related diversification, advertising, and quality of customer relations. Those with an operating background will concentrate on automation, equipment newness, ability to expedite deliveries, actual performance of the service, and overall quality of the service. The maintenance/safety point of reference will stress on-time performance and lack of downtime due to equipment failures. Managers with a finance orientation will devote their attentions to competitiveness and simplicity of rate structures.

This research provides additional insight and support for previous studies regarding the organizational structure of LTL motor carriers. The results of the present study confirm that senior level managers in operations- and marketing-oriented functions are more prevalent in the current operating environment and that maintenance and safety functions are less prevalent. However, the data envelopment analysis of this study suggests that during the time period examined, most LTL motor carriers were relatively inefficient in configuring senior management hierarchies in the pursuit of their customer satisfaction objective. The results also suggest that an optimal balance between senior level managers in the four categories can be obtained to reach the targeted objective.

There are compelling reasons in the competitive environment of LTL motor carriers to actively manage this link between senior managers' proficiencies and company strategy. Many shippers are now paring down the number of carriers they use to a specific core group in order to better form win/win partnerships. Large LTL carriers must recognize the urgency to restructure their multi-tier organizational hierarchies and perhaps begin to emulate the more customer-oriented approach of the regional carriers. They will need to continue to simplify pricing structures and maintain higher levels of communication with shippers. The methodology described in this paper is an effective technique to assist LTL firms in benchmarking themselves against their peers in order to reach their strategic goals.

NOTE

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THE IMPACT OF STATE TAXES ON THE DEVELOPMENT AND GROWTH OF THE TRUCKING INDUSTRY

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ABSTRACT

The presence of certain state taxes is believed to have a negative impact on truck registration and the location decisions of trucking firms. For example, in a metropolitan area that covers two or more states, a trucking firm might not choose to locate in the county that is in close proximity to the metropolitan area's business districts, population centers, and largest concentration of customers, if that county is in a state that imposes the taxes. Instead, it might choose to locate in a county that belongs to another state that does not impose such taxes as long as that county is adjacent to the metropolitan area's most industrialized districts. This paper examines the impact that state taxes have on the very competitive trucking industry. Through a case study of Kentucky, we illustrate how state taxes such as the motor vehicle usage tax and the weight distance tax can adversely affect the trucking firm's decisions in registering and plating trucks, and in locating its facilities.

BACKGROUND

On the average, a typical U.S. trucking firm earns only 3 to 4 cents on the dollar after taxes, compared to the 7 to 9% average profit margin of the heavy manufacturing industry (Dun and Bradstreet, 1999). As such, there is a growing concern regarding the profitability of the U.S. trucking industry, despite strong shipment growth and a moderate increase in freight rates over the last few years. Such anxiety partially originates from volatile fuel prices, and chronic truck driver shortage and retention problems. To make matters worse, some states such as Kentucky, still levy taxes on regionally based trucking firms and their assets. These taxes include the motor vehicle usage tax (MVUT) and the weight distance tax (WDT). These taxes can further reduce the trucking industry's thin profit margin and exacerbate its competitiveness.

For instance, in Kentucky where both MVUT and WDT are still intact, it has the second highest trucking business failure rate among eight neighboring states (see Appendix A). Such a high business failure rate is puzzling, given that the average revenue per trucking establishment in Kentucky during 1997 was above the national average and far greater than those of three neighboring states (Missouri, Virginia, and West Virginia) (See Appendix D). Many trucking firms believe that Kentucky's unique tax policy is the culprit.

Kentucky's MVUT is similar to taxes charged in many other states. It is basically a sales tax on all motor vehicles, including the rolling stock purchased by trucking firms. Some states, such as Kentucky, make all rolling stock fully taxable, whereas others cap the tax at a maximum fee or apportion it according to mileage driven in state. The last two methods are often less of a burden than those imposed by full coverage. Florida apportions sales taxes so that the more a truck is driven out of state, the less its owner pays. Some states, such as Indiana, exempt rolling stock from usage/sales taxation completely (*American Trucking Association*, 2000).

For example, a $100,000 purchase of rolling stock by a trucking firm that chooses to register and plate the truck in Kentucky, results in the owner having to pay an additional $6,000 in usage/sales taxes (6% sales tax ´ $100,000). In Indiana, where rolling stock is exempt from that state's sales taxes, an owner would not have to pay $6,000. A trucking firm owner in Kentucky would do better to license his/her truck in Indiana and buy parts or rolling stock from an Indiana supplier than to conduct such transactions in Kentucky. In states where there is a cap, like North Carolina or Vermont, the owner pays a pro-rated amount of what the tax bill would ordinarily be. Since equipment costs account for 34.3% of a truckload carrier's costs, MVUT can raise an owner's cost of capital substantially and thus can be perceived as an economic burden by the carrier (Boyer, 1998).

Kentucky's weight distance tax (WDT) is unique in that Kentucky is one of only four states (Kentucky, New York, New Mexico, and Idaho) that levy such a tax. Weight distance taxes also have been called ton-mile taxes or ton-axle taxes in other states because the intent of such taxes is to penalize the heaviest users of roadways and those who cause the greatest amount of depreciation in highway pavement and infrastructure. Thus, the owners of large, heavy commercial trucks pay a greater amount in taxes to a state's road fund than would the owners of much smaller vehicles. These trucks usually have five or more axles for both tractor and trailer and usually weigh around 60,000 pounds or more. From a public finance standpoint, such a tax makes sense if the heaviest user of a public good can be identified.

The dilemma is whether the user can pay the tax, and if so, can the tax be collected in a fair and efficient manner using self-reports. If not, some trucking firms will take the opportunity to "cheat" on taxes. Their marginal costs of creating road depreciation and restoration are borne by someone else (Boyer, 1998). In this situation, collecting the tax in a fair and efficient manner becomes problematic, since typical trucking firms cross many jurisdictional lines and self-report the taxes. To make matters complicated, there is no reciprocity among the states to collect these types of taxes that are different from fuel taxes and registration fees. In the past, both Ohio and Wyoming eliminated WDT because of the paperwork burden, the cost associated with the maintenance and expansion of ports of entry, and high rates of tax evasion by firms that were headquartered out of state (Smith and Associates, 1981; Curran and Stewart, 1982).

The main purpose of this study is to examine whether MVUT and WDT were detrimental to the state's trucking industry development and growth. In so doing, we analyzed available secondary data summarized in Appendices A though D and then conducted an empirical survey of trucking executives.

RESEARCH METHODOLOGY

By examining secondary data sources such as the Census Bureau's *Censuses of Transportation* (1982, 1987, 1992, and 1997); *County Business Patterns* (1967 to 1996); *Vehicle Inventory and Use Surveys* (1982,1987, 1992, and 1997); and *Censuses of Manufactures* (1982, 1987, 1992, and 1997) along with business failure rate records from *Dun and Bradstreet* (1999), we found Kentucky's trucking industry to be less profitable than most of the neighboring states. Kentucky and its major urban areas were behind other localities regarding the average size and number of trucking establishments, the number of trucks registered in each state, and the percentage of the area's workforce devoted to trucking. Although Kentucky had made strong gains in manufacturing over the years, and its labor force was roughly the same size as Tennessee's and Virginia's, the trucking industry did not do well when compared to surrounding states' trucking industries (See Appendices A through D).

Sample

In an effort to assess how the managers or owners of a firm felt about the state's MVUT and WDT, a special mail questionnaire was developed for trucking executives whose firms are based in Kentucky and Indiana. The questionnaire contained various questions related to the size of the fleet owned by the responding firms, their annual gross revenue, the primary location of truck registration and plating, the perceived effects of MVUT and WDT on the responding firm's trucking establishments and operations, and business climate with regard to the trucking industry. A sample of 500 respondents was randomly selected from both the *Kentucky Motor Transport Association (KMTA)* members and the *National Motor Carrier Directory* (1999) members based primarily in the states of Kentucky and Indiana. A survey was sent out in the fourth quarter of 1999 and some responses were received into early 2000. From this sample, a total of 112 trucking companies responded to the questionnaire. This produced a usable response rate of 22.4% that is higher than the 20% cut-off rate that is considered desirable for a valid survey (Yu and Cooper, 1983).

For-hire carriers made up 79.3% of the respondents. About half (54.4%) of the respondents had medium to large size trucking fleets (i.e., 11 trucks or more). More than half (60%) of the respondents turned out to be large carriers that reported annual revenues of $1 million or more. Before it was dismantled in 1995, the Interstate Commerce Commission (ICC) classified large carriers as those that engaged in interstate transportation and had revenues of $1 million or more (Silverman et al., 1997). A majority (70.1%) of the respondents said their trucks are primarily licensed or plated in Kentucky. Some of the responding firms' trucks are licensed or plated in Indiana (10.3%), Tennessee (6.2%), Illinois (4.1%), Ohio (4.1%), and other states (5.2%). More than half (57%) of the trucking firms that plate the majority of their trucks in Kentucky are small carriers who own less than 10 trucks. None of the large carriers (i.e., those fleets totaling 50 or more trucks) had vehicles plated in Kentucky. With these numbers, one can see how a great number of all firms' trucks could be plated out of state although 70% of the firms indicated that their trucks are primarily licensed or plated in Kentucky.

"Plating" a truck is the payment of a license fee to a state. Plating a truck in a particular state should indicate where the truck's main terminal is located, but this is not always the case. Registration fees vary from state to state, and how much a company has to pay in registration fees to a state depends upon how many miles the company's trucks drive in that state for a given year. If a truck owner plates a truck in a particular state, he/she ends up paying first year registration fees to that state for distribution to all states in which the truck plans to operate, based upon projected use of the truck. If a new truck is plated or licensed or registered in Kentucky, then it pays its fees to the Commonwealth of Kentucky. If a Kentucky licensed truck drives any distance in Indiana, Illinois, Tennessee, and/or any other state, then

it must pay its part of its Kentucky fees to these states based upon the number of miles driven within each state. For example, an 80,000 pound Kentucky licensed truck that is driven 30% of the time in Kentucky, 40% of the time in Indiana, and 30% in Tennessee will pay 30% of its roughly $1,260 registration fee to Kentucky, 40% to Indiana, and 30% to Tennessee.

Considering that some trucking firms tend to register and plate their trucks out of state to minimize tax payments, we asked respondents about their "plating" decisions and why they decided to register and plate a truck as they did. MVUT appeared to heavily influence plating decisions, since 60% of the respondents agreed that Kentucky's MVUT makes it too expensive to buy trucks and parts in the state (see Table 1). Almost half (49%) of the respondents agreed that Kentucky's WDT makes it costlier to plate their trucks in the state. On the other hand, a majority of the respondents seemed to agree that the amount of required paperwork, and the demand for a local firm's services did not matter when it came to plating decisions (see Table 1).

Because of the WDT and MVUT, there is an incentive to plate and register trucks in a state other than Kentucky. To minimize the WDT payment, owners in Kentucky have an incentive to report more miles driven in other states. Fuel taxes are reported separately from WDT records. To avoid Kentucky audits for the WDT, a truck owner might report that its truck drove 30% of its miles in Kentucky, and 70% in Indiana for the WDT payment (although the breakdown might actually be 50/50 for fuel taxes). Furthermore, it would probably be in the owner's best interests,

TABLE 1
DETERMINANTS AFFECTING THE TRUCKING FIRM'S PLATING DECISIONS

Determinants	The Degree of Agreement*				
	SA	A	A/D	D	SD
Kentucky's motor vehicle tax makes it too expensive to buy trucks and parts in the state.	48.0%	12.0%	2.0%	10.0%	28.0%
If the motor vehicle tax were repealed, our firm would plate all of its trucks in Kentucky.	36.0%	18.0%	12.0%	6.0%	28.0%
Our suppliers and customers are located over a vast area.	21.7%	28.3%	20.0%	19.6%	10.4%
Kentucky's weight distance tax makes it costly to plate our trucks in the state.	39.2%	9.8%	15.7%	15.7%	19.6%
Kentucky has a bad labor climate compared to other states.	18.0%	18.0%	40.0%	14.0%	10.0%
Kentucky's labor force is not adequate so we must locate trucks elsewhere.	10.9%	26.1%	32.6%	17.4%	13.0%
Kentucky's safety regulations make it costlier to plate trucks in the State.	22.0%	10.0%	34.0%	16.0%	18.0%
Kentucky requires too much paperwork in order to plate a truck within the state.	12.0%	16.0%	42.0%	18.0%	12.0%
There is insufficient demand in Kentucky for our firm's services	12.0%	16.0%	26.0%	18.0%	28.0%

*SA = Strongly Agree A = Agree A/D = Neither Agree Nor Disagree D = Disagree SD = Strongly Disagree

as long as the firm remains close to its customers, to physically relocate to another state where he/she will report more miles driven within that state and/or other states. Doing this will help the owner to minimize WDT payments and the possibility of an audit.

There is no reciprocity among states to collect the WDT as there exists with the collection of fuel taxes. It also entices the owner to plate his/her trucks in the state that does not have a WDT. This can also be done to avoid Kentucky's MVUT. Most records on how much and where the truck travels will come from a firm's fuel tax reports that are mandated by all 50 states under the Interstate Fuel Tax Agreement (IFTA). These reports help reallocate and readjust gas tax receipts from state to state. If gas taxes are paid by a truck driver who fills up his tank in Louisville, and yet the fuel is used in Indiana, then all taxes collected in Louisville should go to Indiana.

Considering the additional tax burden, some firms (41.5%) indicated that they had thought about moving their business from the state. More than one third of the respondents (40.2%) doubted that all firms accurately report their mileage driven in the state of Kentucky. Also, due to perceived adverse effects of MVUT and WDT, some firms (44.4%) would prefer to pay more in registration fees and diesel fuel taxes than to pay the MVUT and WDT (see Table 2).

Since Tables 1 and 2 show a large number (a total of 16) of constructs, the authors needed to identify a smaller set of common factors that account for most of the observed variation in responses. An exploratory factor analysis of the responses served this purpose. The factor analysis was used to determine the minimum number of common factors needed to explain correlation among the factors using the eigenvalue greater-than-one rule. To obtain a more meaningful representation of the factor structure, we used the *Varimax* rotation with *Kaiser Normalization*. As summarized in Table 3, we extracted four common factors: (1) tax burdens; (2) business climate; (3) business hassles; and (4) interstate operations. These factors may have affected a trucking firm's decisions to plate a truck out of state.

Hypothesis Development and Testing

Based upon the sample described earlier, we developed the following key hypotheses to validate the economic implications of MVUT and WDT for Kentucky's trucking industry.

H_1: A trucking firm's perception that Kentucky's MVUT makes it too expensive to buy trucks and parts in the state significantly influences its decision to register and plate trucks out of state.

Considering the added capital cost resulting from MVUT, we attempted to examine whether the presence of MVUT has affected the trucking firm's decision to register, plate, and locate out of state. For example, we discovered that some trucking firms had left the city of Louisville and Jefferson County in Kentucky and had relocated to an adjoining county across the Ohio River in southern Indiana where neither MVUT nor WDT was imposed. Among the respondents whose firms are headquartered in and/or have substantial operations in Kentucky, a majority indicated that their trucks are primarily registered or plated out of state, such as in Indiana, Illinois, and Tennessee.

The premise is that the MVUT discourages the trucking firm to register, plate, or establish in Kentucky. To test such a premise, we paired the dummy dependent variable (1 = a decision to register or plate trucks out of state, 0 = a decision to stay in Kentucky) with the independent variable "the degree of agreement with the statement that Kentucky's MVUT makes it too expensive to buy trucks and parts" (1 = strongly disagree, 5 = strongly agree). The result of the regression supports H_1 at $\alpha = .05$ (*p-value* = .0265).

H_2: A trucking firm's perceived burden of Kentucky's WDT significantly influences its decision to register and plate trucks out of state.

TABLE 2
PERCEIVED TAX BURDENS AND THEIR EFFECTS ON TRUCKING ESTABLISHMENTS AND GROWTH

Perceived Tax Burdens	The Degree of Agreement*				
	SA	A	A/D	D	SD
All trucking firms, whether based in Kentucky or out of state, do their best to accurately report the number of miles they drive within Kentucky.	22.5%	25.2%	12.1%	24.3%	15.9%
Aside from some problems, our firm is very competitive with out-of-state-based competition.	13.1%	31.8%	23.4%	26.2%	5.5%
It would be better for our firm to pay more in registration fees and diesel fuel taxes than to continue to report and pay the weight distance tax and/or motor vehicle usage tax.	25.5%	18.9%	26.4%	14.2%	15.0%
Our firm has thought about leaving the State of Kentucky.	28.3%	13.2%	24.5%	13.2%	20.8%
Kentucky's motor vehicle usage and weight distance taxes make it difficult to expand our business.	22.5%	16.8%	22.4%	19.6%	18.7%
Aside from some problems, Kentucky has a very good business climate for the motor freight industry.	6.5%	28.0%	26.3%	28.0%	11.2%
Exemption from the motor vehicle usage tax was a factor in our firm's decision to locate in an enterprise zone or to stay in an area that was later declared an enterprise zone or part of an enterprise zone.	23.1%	11.5%	38.5%	11.5%	15.4%

*SA = Strongly Agree A = Agree A/D = Neither Agree Nor Disagree D = Disagree SD = Strongly Disagree

Similar to hypothesis H_1, trucking firms are expected to move away from a state (Kentucky) where the WDT is imposed. Also, WDT is difficult for the trucking firm to monitor. Thus, we posit that the trucking firm tends to register or plate trucks out of state to avoid the WDT. We paired the dummy dependent variable (1 = a decision to register or plate out of state, 0 = a decision to stay in Kentucky) with the independent variable "the degree of agreement on the perceived impact of the WDT on the expense of plating" (1 = strongly disagree, 5 = strongly agree). Contrary to expectations, the regression results indicate that there is no statistically significant relationship between these variables at $\alpha = .05$ (*p-value* = .6053).

H_3: A trucking firm's concern over the inadequate labor force in Kentucky significantly effects its decision to register and plate trucks out of state.

Considering a record low unemployment rate and the subsequent labor shortage (especially among truck drivers) in Kentucky, it was assumed that the labor shortage contributed to the departure of some trucking establishments. To test this hypothesis, we measured the independent variable, "the degree of agreement on the perceived labor shortage in Kentucky" on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). This variable was paired with the same dummy dependent variable that we used in the

TABLE 3
FACTOR ANALYSIS RESULTS

Factors and Items	Loadings
Factor 1: Tax Burdens of MVUT and WDT (Eigenvalue: 7.378)	
1. The MVUT and WDT make it difficult to expand business.	.968
2. If the MVUT were repealed, firm would plate all trucks in Kentucky.	.914
3. Willingness to pay more in registration fees and diesel fuel taxes than to continue to report and pay MVUT and WDT.	.912
4. Firm has thought about leaving the state.	.877
5. MVUT makes it difficult and too expensive to buy trucks and parts.	.871
6. If WDT were repealed, firm would plate all trucks in Kentucky.	.850
7. Exemption from MVUT was a factor in locating in an enterprise zone.	.757
8. WDT makes it too costly to plate in Kentucky.	.704
Factor 2: Business Climate (Eigenvalue: 5.318)	
1. Kentucky has a very good business climate.	-.916
2. Kentucky has a bad labor climate.	.863
3. Kentucky's labor force is not adequate.	.813
4. Kentucky's safety regulations make it costlier to plate trucks in the State.	.753
Factor 3: Business Hassles (Eigenvalue: 1.879)	
1. Too much paperwork to plate a truck.	.971
2. Insufficient demand for services.	.793
3. Suppliers and customers are located over a vast area.	.615
Factor 4: Interstate Trucking Operations (Eigenvalue: 1.292)	
1. Accurate report of the number of miles driven within Kentucky.	.917
2. Competitiveness in out-of-state trucking.	.901

Reliability Coefficient = .9018

previous two hypotheses. The regression analysis indicates that the decision to register or plate out of state is significantly related to the inadequate labor force in Kentucky at $\alpha = .05$ (*p-value* = .0172). Somewhat congruent with this result, more than one-third (36%) of the respondents agreed that Kentucky has a bad labor climate compared to other states (see Table 1).

H_4: A trucking firm's resistance to costly safety regulations in Kentucky significantly effects its decision to register and plate trucks out of state.

Safety regulations could have caused trucking companies to relocate due to increased safety standards on trucks and subsequent cost increases that accompany compliance. Thus, we hypothesized that Kentucky's safety regulations had driven some firms out of the state. Results of the regression, however, forced the rejection of this hypothesis. In other words, no significant relationship between the trucking firm's registration/plating decision and the degree of agreement on the negative consequence of safety regulations at $\alpha = .05$ (*p-value* = .0908) was found.

H_5: A trucking firm's resistance to excessive paperwork requirements in Kentucky significantly effects its decision to register and plate trucks out of state.

In the case of both Wyoming and Ohio, the burden of the paperwork necessary for compliance with the WDT was one of the main reasons why WDT was made a candidate for repeal in those states. Therefore, we made a premise that the excessive paperwork requirement is yet another reason for plating a truck out of state. Contrary to our expectation, this hypothesis was rejected at $\alpha = .05$ (*p-value* = .6826).

H_6: The trucking establishment in a state (as measured by the number of general freight, long-distance, 5-axle trucks registered in the state for a given year) is inversely related to the presence of WDT, MVUT, diesel taxes, and/or registration fees.

Kentucky's situation raises questions as to whether trucking firms throughout the nation engage in the same tax avoidance behavior. To see if Kentucky's situation can be generalized to other states, we attempted to examine whether various taxes have negative consequences on trucking establishments in any given state. In particular, we used the number of general freight, long distance trucks as a surrogate measure for the number of trucking establishments in a given state. The rationale is that less-than-truckload (LTL) and/or short-haul carriers do not usually have very large trucks that would be covered by the WDT and usually do not travel outside of a limited geographic area. These carriers have to stay very close to customers, due to the perishable nature of their freight such as milk, frozen foods, and agricultural products. These regional LTL carriers are often exempted from state taxes. In Kentucky, for example, many LTL carriers that exclusively ship agricultural goods are exempt from various taxes that other trucking firms must pay.

Considering the possibility that some trucking firms would locate their trucks out of state to avoid taxes, we postulated that the number of registered trucks (large, general freight, commercial 5-axle trucks weighing at least 60,000 pounds) is likely to be smaller in states which have one or more taxes such as MVUT, WDT, and diesel fuel taxes than in those states which do not impose such taxes. Similarly, registration fees may have effected trucking establishments in a given state adversely.

Prior to testing the above hypothesis, we developed a fifty state database using the quinquennial publications of the *Census of Transportation, Census of Manufactures,* and *Vehicle Inventory and Use Survey* for the years 1987, 1992, and 1997. In addition, tax data was gathered from the American Trucking Association (ATA). As a preliminary testing procedure of hypothesis H_6, we measured to what degree a relationship exists between dependent and independent variables through correlation matrices summarized in Table 4. Since significant correlations were identified among the independent variables at $\alpha = .05$, we conducted additional statistical tests by using step-wise regression to eliminate redundant independent variables such as WDT and diesel fuel taxes.

Test results shown in Table 5 indicate that the trucking establishment, in terms of number of registered trucks in each state, is inversely related to the presence of MVUT, whereas the number of trucking establishments is positively related to the presence of registration fees at $\alpha = .01$. On the other hand, both WDT and diesel fuel taxes per gallon are not significantly correlated with the number of trucking establishments. Therefore, H_6 is not fully supported by our test results.

TABLE 4
CORRELATION MIX

	Number of Trucks	MVUT	WDT	Diesel Fuel Tax	Registration Fees
Number of Trucks	1.0				
MVUT	-.213**	1.0			
WDT	-.122	.051	1.0		
Diesel Fuel Tax	.201**	.043	-.237**	1.0	
Registration Fees	.273**	.015	-.323**	.418**	1.0

**p < .01

TABLE 5
STEPWISE REGRESSION RESULTS

Dependent Variable: Number of general freight, long-distance, 5-axle trucks registered in each state at a given time

Independent Variables	Unstandardized Slope Coefficient	Standard Error	Standardized Coefficient (Beta)	Significance Level
Constant	6951.004	3573.593		.000
MVUT	-4705.410	1675.423	-.217	.006**
Registration Fees	10.296	2.877	.277	.000**
WDT	Excluded	Excluded	Excluded	.768
Diesel Fuel Tax	Excluded	Excluded	Excluded	.177

F-ratio = 10.204, significant at p < .01 **p < .01

One thing to note is that there is a significantly positive relationship between the number of trucking establishments and the presence of registration fees. This is contrary to expectations, but could explain why most of the respondents prefer to pay registration fees over the MVUT. Perhaps reporting and paying registration fees are much easier to administer and require less paperwork than paying the MVUT. Higher registration fees have been used in the past in many states to replace the revenue lost from the repeal of the WDT. Another rationale may be that higher registration fees are not an administrative burden.

Also, states that have the strongest demand for trucking services and travel might be able to charge higher fees to all trucks coming into their state because truck registration fees are based upon the number of miles that a truck drives in each state. Those states in which a lot of miles are driven can charge higher fees, because carriers have inelastic demand for those states' roadways. Finally, if business is good enough,

and shipments to or from a particular state are very high, higher fees are not problematic for trucking firms.

H_7: The trucking establishment in a state (as measured by the number of general freight, long-distance, 5-axle trucks registered in the state for a given year) is positively correlated with the value of manufactured goods shipped from each state.

Costelleo and Saltes (2000) recently observed that growth patterns in revenues for the trucking industry are strongly linked to increases in consumer spending and manufacturing activity. In other words, trucking firms tend to adjust their shipping volume and the subsequent trucking establishment as demand increases. Since trucks shipped 75% of all manufactured goods in 1993 and 78% in 1997, we feel that the value of the manufactured goods shipped is a good proxy value for the demand of trucking services. Therefore, we posit that the value of goods shipped should be a good indicator of the number of trucks (or trucking establishments) in a given state.

To test the above hypothesis, we paired the independent variable "value of goods shipped" with the dependent variable "trucking establishment." Both correlation and simple regression analyses indicate that the value of goods shipped has a strong positive relationship with the number of trucking establishments (in terms of number of trucks) at $\alpha = .01$ ($r = .768$ and *p-value* = .000).

MAJOR FINDINGS AND IMPLICATIONS

This section summarizes key findings of the study and the practical implications for trucking firms who must cope with stringent state tax and regulatory policies.

First, the MVUT is perceived to be a heavy burden for most of the responding firms and consequently has become a major motivating factor behind some firm's attempts to move away from Kentucky. It would be better for a Louisville trucking firm to locate in southern Indiana, register its trucks there, and buy rolling stock in southern Indiana in order to avoid paying $.06 for every dollar of capital equipment bought because Indiana does not levy such a tax. An office headquartered in southern Indiana could be a simple one-room operation while the company's main operations remain in Kentucky, or the whole company and its facilities could move to southern Indiana.

Considering that the MVUT can substantially increase the owner of a trucking firm's cost of capital, it is not surprising to find that Kentucky has relatively few trucking establishments with 100 or more employees (see Appendix B). However, defying our common sense, neither the WDT nor diesel fuel tax appeared to be an important deterrent to the number of trucking establishments in a given state. As evidenced by our 50 state data analyses, such a pattern can be generalized to other states. Similarly, strict safety regulations and excessive paperwork requirements have no significant influence on the trucking firm's plating and registration decisions.

Second, we discovered that registration fees were *positively, not negatively* correlated with trucking establishments. The positive sign for registration fees can be explained by the mutually exclusive tax policy of many states. By examining the data for the 50 states, those states that have higher than average registration fees usually do not have the MVUT. These states, on average, also have a higher number of registered large trucks and trucking establishments in their jurisdictions. Perhaps this is one of the reasons why the registration fee increase is the most commonly chosen alternative, whenever the MVUT, the WDT, or another form of taxes on trucks is repealed and/or replaced by increases in other taxes.

Finally, despite a dramatic increase (by 102%) from 1987 to 1992 in the amount of manufactured goods shipped in Kentucky and its positive impact on the trucking industry, the number of heavy trucks registered in Kentucky has shown anemic growth. As a matter of fact, Kentucky

ranked first among eight neighboring states we examined with respect to value of goods shipped, but ranked last with respect to growth in trucking firms (or the number of trucks). In particular, we find that the number of trucks used by for-hire and owner-operated carriers located in Kentucky declined between 1987 and 1997. This disparity may have stemmed from the fact that out of state firms, who are free from additional tax burdens, and consequently become more price competitive than Kentucky-based firms, take some trucking business away from Kentucky. The verification of such a fact requires further research.

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APPENDIX A
AVERAGE TRUCKING BUSINESS FAILURE RATES
1984 - 1995

State	Failure Rate per 10,000 Firms
Tennessee	456
Kentucky	***434***
Indiana	423
West Virginia	401
Illinois	352
Ohio	345
Missouri	343
Virginia	340

Source: Dun & Bradstreet, Inc.

APPENDIX B
SIZE CONSIDERATIONS: TOTAL EMPLOYMENT, AVERAGE NUMBER OF EMPLOYEES PER ESTABLISHMENT, AND ESTABLISHMENTS WITH MORE THAN 100 EMPLOYEES
1996

State	Total Number of Employees	Average Number of Employees	Establishments with 100 or More Employees
Illinois	94,733	16	120
Ohio	81,169	16	115
Indiana	55,181	16	77
Tennessee	52,636	19	68
Missouri	48,186	13	56
Virginia	36,901	12	49
Kentucky	***22,976***	***10***	***29***
West Virginia	9,963	8	8

Source: US Census Bureau's *1996 County Business Patterns*

APPENDIX C
AVERAGE SIZE OF TYPICAL TRUCKING ESTABLISHMENT
1996

Primary Metro County	Average Number of Employees	Average Estimated Annual Pay
Nashville–Davidson County	55	$31,289
Indianapolis–Marian County	44	$30,748
Shelby County (Memphis)	39	$31,284
Hamilton County (Cincinnati)	38	$31,558
St. Louis County	27	$29,520
Jefferson County (Louisville)	***25***	***$28,591***
Lexington-Fayette County	***24***	***$26,952***
United States	**15**	**$29,999**

Source: US Census Bureau's *County Business Patters*

APPENDIX D
AVERAGE REVENUE PER ESTABLISHMENT IN A GIVEN STATE

Data from 1992 *Census of Transportation*

General Freight Trucking—Long Distance

State	Estab.	Total Revenue ($1,000)	Annual Payroll ($1,000)	Paid Emp.	Avg. Emp.	Avg. Pay	Avg. Rev. per Estab.
Ohio	1,346	$ 2,961,495	$ 887,534	28,492	21	$31,150	$2,200,219
Illinois	1,179	2,998,419	934,268	29,079	24	32,129	2,543,188
Indiana	1,020	2,162,543	644,813	23,432	23	27,518	2,120,140
Missouri	980	1,840,875	563,042	21,416	22	26,291	1,878,444
Tennessee	842	2,310,043	711,258	24,184	29	29,410	2,743,519
Virginia	569	914,598	269,331	10,047	18	26,807	1,607,378
Kentucky	***388***	***695,481***	***169,608***	***6,636***	***17***	***25,559***	***1,792,477***
West Virginia	158	197,030	53,575	2,264	14	23,664	1,247,025
United States	**25,014**	**55,257,352**	**15,879,651**	**553,202**	**22**	**28,705**	**2,209,057**

Data from 1997 *Census of Transportation*

General Freight Trucking—Long Distance

State	Estab.	Total Revenue ($1,000)	Annual Payroll ($1,000)	Paid Emp.	Avg. Emp.	Avg. Pay	Avg. Rev. per Estab.
Ohio	1,343	$ 3,754,484	$ 1,144,951	32,113	24	$35,654	$2,795,595
Illinois	1,339	4,040,036	1,274,731	35,497	27	35,911	3,017,204
Indiana	1,174	3,151,455	867,479	27,799	24	31,205	2,684,374
Missouri	1,227	2,249,398	683,650	22,093	19	30,944	1,833,250
Tennessee	1,070	3,372,817	1,149,924	34,911	33	32,939	3,152,165
Virginia	701	1,251,999	385,642	12,657	18	30,469	1,786,017
Kentucky	***491***	***1,285,855***	***292,380***	***9,428***	***19***	***31,119***	***2,618,849***
West Virginia	175	214,519	63,985	2,211	13	28,939	1,225,823
United States	**29,321**	**76,152,239**	**22,200,009**	**684,730**	**23**	**32,422**	**2,597,191**

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THE USE OF EDI AND INTERNET TECHNOLOGIES IN THE U.S. MOTOR CARRIER INDUSTRY

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ABSTRACT

Computer to computer data exchange by companies in a supply chain have been well-recognized as an effective means of reducing cost and decreasing paperwork errors. In many cases, manufacturers, wholesalers, and retailers have become electronically linked to better manage inventory, ordering, and billing information. However, supply chains, by definition, also include common carriers that move goods between supply chain partners but may not have a long-term relationship with either the shipper or his customers. This could be the missing or weak link in an otherwise effective supply chain. The purpose of this paper is to examine the state-of-the-art of EDI in the motor carrier industry to identify possible trends.

Electronic Data Interchange (EDI) systems have been used by shippers and carriers since the late 1970s. This article reports on findings of a recent survey of large domestic motor carriers regarding their use of EDI and emerging Internet technologies to provide vital information links with their supply chain partners.

INTRODUCTION

Various forms of computer-based information technology (IT) have been used to facilitate business-to-business transactions for at least three decades. During the 1970's, suppliers and customers began linking mainframe computers to facilitate direct data exchange. Suppliers could receive and complete orders without a manual purchase request from the customer. Data from the inventory tracking and production systems could be transmitted to the supplier through Electronic Data Interchange (EDI) communication links. A purchase order could automatically be submitted. Invoices could be sent and payments made through Electronic Funds Transfers (EFT). In the freight transportation industry, freight forwarders and shippers gained access to airline, rail, ship, and truck schedules permitting them to book cargo directly utilizing EDI. These pockets of technology development redefined logistics processes and, by the late 1980's, became mandatory for companies seeking to maintain their competitiveness.

To engage in traditional EDI, business partners must add three components to their existing computer systems: EDI standards, EDI

translation software, and some sort of transmission capacity. To illustrate the underlying concept, Emmelhainz provides the analogy of an American dealing by mail with a trading partner in Germany (1993). To successfully communicate, the parties would require a letter written in "generally accepted business format", translation capacity from English to German, and a mail service or other method of transmission. With an electronic transfer, EDI standards furnish the format, EDI software provides the translation, and either direct links or value added networks (VANs) are utilized.

The key to EDI has been the development and implementation of standards—standard business procedures, standard definition of business terms and standard documents. After considerable effort the Transportation Data Coordinating Committee (TDCC) adopted data interchange standards in the mid-seventies for domestic shipments. This action greatly enhanced the transportation use of EDI in the United States. In the early eighties, the American National Standards Institute's (ANSI) standards committee X12 took over the task of expanding U.S. industry standards in transportation. And by the mid-eighties, the United Nations had created EDI for Administration, Commerce, and Transportation (EDIFACT). In 1992 the U.S. voted to adopt the structure and syntax of EDIFACT. However, since the official adoption of EDIFACT as the worldwide standard, few U.S. transportation carriers have implemented new traditional EDI systems. Reasons cited include EDI complexity and cost, growth of customized systems (lack of true standard systems) and the superiority of Internet based information systems.

Since the mid-1980's, supply chain managers at progressive companies in competitive industries have increasingly turned to Internet based information technologies to facilitate business-to-business logistics transactions like purchasing, order processing, inventory management and transportation tracking. For example, in 1995 Michelin N.A. began building a customized extranet system so their small to midsize customers could shop and buy on-line as well as track their shipments from origin to destination. At the same time, Michelin N.A.continued to operate a traditional EDI system for their large volume customers. Soon after their extranet system was implemented, Michelin's EDI customers wanted to be on the extranet because they found it to be superior to EDI (Smith, 1999).

While the literature contains many publications dealing with information technology and SCM there is little published research on the current use of IT (EDI and Internet systems) by the U.S. motor carrier industry. Truck transportation in the U.S. very often provides the vital physical link between suppliers and their customers. In fact, trucks carry approximately 80% of the U.S. domestic freight by revenue according to a Cass Logistics 1999 study (Barber, 1997). Unfortunately, the physical movement of goods today is often still impeded by ineffective information flows that have not kept pace with developments in information technology. The American Trucking Association estimates that required paperwork still can reach as much as $900 per truckload in the worst case scenario ("Information...", 1999). The clear implication is improvements in both EDI and web-based IT may not yet have been realized in the trucking business. The purpose of this paper is to present the results of a recent study undertaken to evaluate the current level of EDI and Internet based technology utilization among the largest carriers in the U.S. motor carrier industry. First, a brief literature review will be presented, followed by an explanation of the research methodology employed. The results will then be discussed and conclusions drawn concerning the future of EDI and Internet based information technology in the motor carrier industry.

LITERATURE REVIEW

A review of the recent literature on EDI usage in transportation indicates that most applications are shipper, customer, or carrier specific. Miller reported that over 50 percent cent of EDI systems used by motor carriers were proprietary

and included unique message formats (1995). Johnson, Allen and Crum found that while the number of motor carriers using EDI increased over 100 percent form 1987 to 1990, EDI usage was mostly limited to individual carrier-shipper transactions (1992). In a more recent survey, Seideman found that large shippers typically require industry-specific transaction data and will only utilize motor carriers able to provide that unique information (1992). It also appears that customer size makes a difference when it comes to establishing EDI links with carriers. According to a 1993 logistics technology and benchmarking survey conducted by KPMG Peat Marwick and Company, 61 percent of shippers with annual revenues exceeding $500 million have established EDI links with carriers. Only 35 percent of companies with annual revenues under $500 million had done so by 1993 (Information, 1999). This same survey also confirmed earlier reports that most EDI systems used by motor carriers were not compatible even within the trucking industry.

More recently, the literature has reported a number of successful implementations of Internet based systems by large motor carriers. Wood found that in 1999, 78 percent of LTL carriers and 62 percent of TL carriers based in Arkansas were using some form of e-commerce to conduct business with their supply chain partners (1999). These carriers include J.B. Hunt Transport Services Inc., American Freight Ways Corp. and USA Truck. Dryden found that many large TL carriers like the $2.5 billion Schneider National have invested heavily in Internet based systems as a better IT alternative to EDI. Schneider's scope of Internet based services is large and includes not only the usual shipment tracking by customers but, also provides links to all of Schneider's business software. Their web-based system unifies data about all modes of transportation in a base of over 1000 rail and motor carriers (Dryden, 1999). Crum, Johnson and Allen studied EDI between U.S. motor carriers and shippers in 1990 and again in 1996. Their longitudinal assessment found the growth of EDI transactions declined in the early nineties. On the other hand, 100 percent of the responding shippers reported using Internet technology for business transactions with their supply chain partners (1998).

In summary, a review of the relevant literature published since 1990 shows that important strides were made by large U.S. motor carriers in the application of EDI technology through about 1995. Since then, it appears there has been a shift away from developing new traditional EDI systems to the use of Internet based formation systems in business-to-business information exchanges involving large motor carriers. Many of the reported Internet applications include the use of standard EDI transportation formats developed in the seventies and eighties suggesting an evolutionary progression of transportation data interchange.

METHODOLOGY

In order to evaluate the use of and prospects for EDI and web-based systems in the U.S. trucking industry, an open-ended questionnaire was developed. This questionnaire contained 15 questions and was patterned after the one used successfully in a 1994 study by Gourdin and Clarke (1994). The questionnaire is shown below in Table 1. To identity the largest U.S. trucking companies, reference was made to a 1997 survey by *Inbound Logistics* that ranked the top 75 U.S. motor carriers in terms of revenues earned from trucking operations (Top 25 motor Carriers, 1998). While over 400,000 for-hire trucking firms are registered with the U.S. Department of Transportation, fewer than 800 had annual revenues exceeding $20 million in 1998 (Coyle, 2000). The largest trucking companies in the U.S. tend to be in the LTL segment which is even more concentrated. The top 10 LTL carriers account for more than 60% of the total less-than truckload business (Coyle, 2000).

The 75 largest trucking companies were targeted for this study because of the likelihood they had experience with both EDI and Internet technologies. The disadvantage of focusing on a small number of very large firms is that the

TABLE 1
SURVEY QUESTIONNAIRE

1. Using EDI?
2. For what?
3. Where was EDI system developed?
4. Is EDI system accessible by outside parties?
5. Whom do you exchange data with via EDI? (type of company or organization)
6. Have you encountered problems with your EDI system(s)? If so, what types of problems?
7. Are your EDI lacking capabilities? If so, what?
8. Using web-based systems?
9. For what?
10. Where was the web-based system developed?
11. Is web-based system accessible by outside parties?
12. Whom do you exchange data with via web-based systems? (type of company or organization)
13. Have you encountered problems with web-based systems? If so, what types of problems?
14. Are your web-based systems lacking capabilities? If so, what?
15. Future trends in Information Transfer?

results may not be generalizable to the trucking industry as a whole. However, the primary goal of the present study was to investigate the current level of EDI among the subset of the trucking industry most likely to have implemented EDI to link their supply chain partners. So, this limitation was considered acceptable.

This list of 75 trucking companies was then cross-referenced to the list of companies with one or more attendees at the 1999 International Council of Logistics Management (CLM) Conference in Toronto, Canada. This was done so that the survey could be e-mailed directly to a senior executive in each trucking company. Fifty-four of the largest 75 U.S motor carriers (72%) were represented at the 1999 international CLM conference. Finally, the most senior attendee was identified by job title (e.g., Presi-dent, VP-operations, VP-Information Systems, etc.) from the published list of conference attendees.

The survey was then sent via e-mail to named executives at 54 of the largest 75 motor carriers in the U.S. Due to the nature of this study, participants were not randomly selected in the strict sense. Rather, large motor carriers most likely to be engaged in both EDI and Internet systems were surveyed. A complete list of the companies surveyed is included in Table 2. The results of the survey are presented and discussed in the next section.

TABLE 2
MOTOR CARRIERS CONTACTED

United Parcel Service	Vitran
Roadway Express, Inc.	Southeastern Freight Line
Schneider National, Inc.	Atlas Van Lines
Consolidated Freightways	FFE Transportation
Penske Truck Leasing	Trimac Specialized Carriers
Ryder Integrated Logistics	CRST Logistics, Inc.
RPS, Inc.	Crete Carrier Corporation
Con-Way Transportation	Covenant Transport
J. B. Hunt Logistics, Inc.	Dart Transit
ABF Freight System	Contract Freighters, Inc.
United Van Lines	Heartland Express
Overnight Transportation	KLLM Transport Service, Inc.
North American Van Lines	Burlington Motor Carriers
American Freightways	Matlack, Inc.
Werner Enterprise, Inc.	New Penn Motor Express
Swift Transportation	Roberts Express
USF Holland, Inc.	USF Red Star, Inc.
Allied Holdings	Celadon Trucking
Watkins Motor Lines	APA Transport
M. S. Carriers	Merchants Home Delivery
Trimac Transportation	Mercer Transportation
U. S. Xpress	New England Motor Freight
Estes Express Lines	Morgan Drive Away
Mayflower Transit	Stevens Transport, Inc.
CTI	Pitt Ohio Express, Inc.
Landstar Logistics, Inc.	Daylight Transport
Averit Express	Allied Van Lines
Viking Freight Systems	

DISCUSSION OF RESULTS

Nine of the 54 e-mailed surveys could not be delivered because of unknown or unrecognized addresses reducing the effective sample size to 43 of the largest 75 U.S. motor carriers. Twenty-one of the 43 trucking executives completed and returned the questionnaire for a response rate of 49 percent. This was somewhat higher that typical response rates for this type of survey probably because of the ease and convenience of e-mail replies. In fact, 17 of the 21 responses were made within 24 hours of the questionnaire's receipt. The use of e-mail surveys in the logistics area seems promising for the future. Table 3 summarizes the respondents' answers to the 15 posed questions.

TABLE 3
SURVEY OF RESPONSES

1. **Using EDI?**
   Yes 100% No 0%

2. **For what?**
   Shipment tracking, tracking billing, electronic payment, load tendering, and ordering

3. **Where was EDI system developed?**
   In house 73% Outside Vendor 9%
   Both 18%

4. **Is EDI system accessible by outside parties?**
   Yes 27% No 55% No Response 18%

5. **Whom do you exchange data with via EDI? (type of company or organization)**
   Shippers, consignees, other trucking companies, railroads, banks, auditors, paying agents, and freight brokers

6. **Have you encountered problems with your EDI system(s)? If so, what types of problems?**
   No Problems 36% Some Problems 55%
   No Response 9%
   start-up problems, excessive cost, lack of true standards

7. **Are your EDI lacking capabilities? If so, what?**
   Yes 55% No 45%
   Lack of true standards

8. **Using web-based systems?**
   Yes 82% No 18%

9. **For what?**
   As alternative to EDI, for partners with limited or no EDI, trade EDI documents, signed purchase orders, shipment customer tracing, tendering orders.

10. **Where was web-based system developed?**
    In House 91% Outside Vendor 9%

11. **Is web-based system accessible by outside parties?**
    Yes 80% No 20%

12. **Whom do you exchange data with via web-based systems? (type of company, organization)**
    Shippers, interline carriers, entire customers base, any customer not using EDI

13. **Have you encountered problems with web-based systems? If so, what type of problems?**
    Yes 12% No 88%
    Start-up bugs, some small customers don't have access

14. **Are your web-based systems lacking capabilities? If so, what?**
    Yes 14% No 60%
    No Response 26%

15. **Future trends in Information Transfer?**
    Standards (similar to ANSI X12) for Internet communication, more use of scanned (documents) info sharing, tracing EDI documents via Internet, faster dial-up process and faster data transmission

EDI use by large U.S. motor carriers is widespread with customer service still the major function supported. All the respondents indicated they used EDI to support one or more business functions. The only EDI transaction all respondents were using for customer service was shipment tracking. A majority of the largest U.S. motor carriers also reported using EDI to transmit freight bills and to generate internal shipment tacking documents.

Surprisingly, only 27 percent of the trucking companies said their EDI system was accessible to outside parties. There may be several possible explanations for this result. Two of the respondents noted they were unsure what was meant by the term "outside parties" and elected not to answer this question. It appears this question was not sufficiently clear to preclude different interpretations. It is also likely that

several of the respondents use EDI with shippers contract carriage (versus common carriage). In this case the trucking companies may not consider the shipper to be an "outside" party.

Respondents who said their EDI systems were accessible to outside parties reported using EDI with a variety of supply chain partners. These included shippers, consignees, freight brokers, and interline trucking companies. Only a few of the respondents indicated they exchanged EDI documents with intermodal carriers (like railroads or airlines) or with financial institutions. More than half of the largest motor carriers included in the sample indicated they had experienced problems with their EDI systems. Problems reported included startup malfunctions, excessive cost and lack of true standards.

Regarding the use of the Internet for business-to-business transactions, slightly over 80 percent of the respondents are currently using web-based technologies to support several functions. Uses include completing and transmitting signed purchase orders, shipment tracking and tracing by customers, exchanging EDI documents and shipment tendering orders. Interestingly, several of the respondents said they use the Internet as an alternative to their EDI system and to communicate electronically with supply chain partners who have limited or no EDI capability. While the types of outside parties with Internet links to the motor carriers is very similar to the EDI links reported in the survey, significantly fewer respondents report having encountered problems with their web-based systems (12 percent versus 36 percent with EDI problems). The results also indicate much greater satisfaction with the capabilities provided by the Internet versus EDI. Only 14 percent of the respondents reported their web-based systems lacked capabilities while 55 percent said their EDI system lacked capabilities.

MANAGERIAL IMPLICATIONS

Internet use is rapidly becoming a basic requirement for U.S. motor carriers as an efficient means of conducting business with their supply chain partners. After 20 years of development, the sole use of traditional EDI by the largest U.S. motor carriers seems to have peaked. The current focus on information technology, at least in this sample of the largest U.S. motor carriers, has shifted away from EDI technology to web-based information technology. There are many solid reasons for this shift.

Customers in supply chains are demanding high quality, timely information as well as on-line billing and payment throughout complex, often international distribution linkages. Customers of the large U.S. motor carriers also want flexible information systems that can very quickly change as information requirements change. This demand, expressed in this survey, clearly favors Internet systems and discourages the growth of new traditional EDI systems that are not flexible or nimble enough to keep pace with changes in business practices. Globalization is also a factor in the shift to the business use of the Internet by large trucking companies. Globalization is increasing competition and adding new supply chain partners who lack EDI capability. The lower cost and speed of implementing new information links via the Internet relative to EDI is a third factor which seems to be influencing motor carriers.

The present survey showed that approximately 90 percent of the largest U.S. motor carriers who responded were able to develop web-based systems in house, avoiding the high development costs often associated with the use of outside venders. Most large trucking companies appear to feel the costs of new EDI development and implementations outweigh potential benefits. Internet systems offer lower cost, more flexibility, and much faster implementation. Even proponents of EDI are saying EDI is too expensive, too complex and too inflexible and offers too few benefits for smaller motor freight shippers.

Apart from the development and implementation cost advantages the Internet offers over EDI, Internet solutions also appear to offer substan-

tial monthly savings in communications cost. EDI network costs are generally based on a charge per character which discourages more volume. On the other hand, Internet access charges from an Internet service provider (ISP) are based on connectivity time or a flat monthly charge. Therefore, transmitting more data actually reduces the cost per character and encourages more volume.

Yet, survey results indicate that EDI is still very common among the largest motor carriers and will likely be used to exchange standard documents with large shippers for the foreseeable future. While motor carriers in the U.S. are not developing new X12 transactions using EDIFACT design rules, existing X12 transactions will likely be maintained and used in conjunction with Internet transmission.

Investments made in EDI appear safe for now, but new investments in EDI by the largest motor carriers seem unlikely. Rather, smaller investments in Internet technologies appear to be more likely. Aside from the cost and time advantages, there may also be an important service reason for the shift to new supply chain information systems. When EDI systems were being designed and developed, the business climate emphasized the efficient handling of large-scale business-to-business transactions. The current business climate emphasizes the end-user. Web-based technologies can link everyone in a supply chain with the ultimate customer.

CONCLUSIONS

This research found that the largest U. S. trucking companies are using both EDI and the Internet to facilitate a variety of transactions with their supply chain partners. Information technology has changed significantly since EDI systems were first introduced. Motor carriers tend to use information technologies in response to customer demand as a matter of customer service rather than for internal information needs. The widespread appeal of the Internet combined with other contemporary factors, including the relative cost of new EDI systems versus Internet systems and the increasing complexity of supply chains, have led large U.S. motor carriers to develop new web-based systems for business-to-business transportation transactions. The growth of EDI by the largest motor carriers has leveled off. While new EDI growth is unlikely for the U.S. motor carrier industry, current EDI systems are being used, especially with large shippers, and will likely be maintained for the foreseeable future.

Over the longer term, however, the lack of standard business practices and procedures among supply chain partners (often even within the same company) will tend to push trucking managers away from costly EDI solutions to cheaper, simpler and faster Internet solutions. In the seventies and eighties, EDI offered motor carriers and their customers the opportunity to eliminate much of the delay associated with the flow of goods. Most large motor carriers developed EDI systems and used them in a proprietary way to support the information demands of their larger customers. In the nineties, the Internet offered a cheaper, more flexible way to transmit important logistics data throughout an entire supply chain. This research has shown that the largest U.S. motor carriers are increasing their use of the Internet for both EDI and non-EDI transmissions. As long as the Internet can support the increasing volume and speed demands, large motor carriers will get closer and closer to paperless transport movements with all their customers.

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AN EVALUATION OF LINER STRATEGIES IN THE CONTEXT OF CONTEMPORARY SUPPLY CHAIN MANAGEMENT PRACTICES

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ABSTRACT

Academic researchers published a sophisticated model of world class logistics in 1995 and recently updated it with a model of 21st century logistics. Although such practices are yet to be perfected in the real world, it provides a yardstick for measuring logistical excellence. An innovative world class firm will pursue sustainable competitive advantage through well-integrated global supply chains. As liner operators are vital members of global supply chains, their contemporary strategies need particular scrutiny to identify elements of congruence or non-congruence. The paper discusses generic liner strategies and identifies the ideal strategy congruent with contemporary supply chain management practices.

INTRODUCTION

We live in an era of increasing business sophistication. The management of business functions has undergone radical reengineering and shifted more towards a system of managing processes rather than functions. Correspondingly, the management of business logistics has gained increasing attention in the last decade and is now considered a core competency of successful firms (Coyle, Bardi, and Langley, 1996). Such firms position themselves through various strategic choices to establish themselves as market leaders in the new millennium. They seek sustainable competitive advantage in the global marketplace through strategic supply chain alliances that provide them logistical superiority. The supply chain alliance partners of these firms include their suppliers and suppliers' suppliers, and customers as well as various transportation providers and intermediaries.

As international business breaks new ground year after year, the management of business logistics will become increasingly global, complex and challenging. The shift towards world-wide manufacturing and assembling operations will lead to a greater role for ocean liner shipping companies who have provided a historically vital service for shippers, large and small alike. This is because of the increasing preponderance of

time-based competition manifested today in various forms. These include the rapid adoption of innovative inventory management philosophies, like just-in-time manufacturing, reduced cycle time and above all, a greater recognition of customer satisfaction.

While these developments are well recognized by all concerned, the dilemma concerning the economic efficiency of ocean liner markets continues today as in the pre-containerization era. Their role in contemporary supply chains is beyond question. However, economists, policy-makers, and academicians perpetually debate the structure of liner markets and their efficiency outcomes. There is a continuing rift between shippers and carriers, and is often reported in trade journals (Mongeluzzo, 1999). There are also perceived fall-outs from the partial deregulation of shipping services in the U.S. (Bryant, 1999). The objective of this paper is to scrutinize contemporary ocean liner strategies given the much wider scope of ongoing changes in the management of business logistics and supply chain management in general. It will highlight areas of mutual congruity and conflict, and will look into a possible new order in liner shipping that may facilitate the establishment of efficient global supply chains.

THE WORLD CLASS LOGISTICS MODEL (1995) AND 21st CENTURY LOGISTICS (1999)

The Michigan State Global Logistics Research Team released their findings on world class logistics in 1995 (Michigan State, 1995). The study, a continuation of their research on Leading Edge Logistics (Bowersox et al., 1989) and Logistics Excellence (Bowersox et al., 1992), led to the development of a model of World Class Logistics (WCL). It identified the need for simultaneous achievement of four key competencies—positioning, integration, agility and measurement—for world class performance. Although the study did not find any firm that had perfected the simultaneous achievement and fusion of all components of the suggested model, it established the existence of world class firms that had made a greater overall commitment in their effort towards logistical perfection (Michigan State, 1995).

Positioning, one of the four key competencies of the WCL model, refers to the selection of strategic and structural approaches to logistics operations. Integration leads to the creation of solid supply chain relationships. Agility is a firm's competency with respect to relevancy, accommodation and flexibility. Measurement refers to the internal and external monitoring of results. The model identified seventeen measurable capabilities under each of the four key competencies. These capabilities of the four key competencies are the vehicles for seeking logistical excellence. The researchers also showed that the seventeen identified capabilities are essentially the same throughout all developed nations and that being world class does matter (Michigan State, 1995).

21st Century Logistics, the most recent research report from the Michigan State Global Logistics Team, updated the WCL model and extended it to the broader concept of supply chain management (Bowersox et al., 1999). It reports that the overall average of world class competency of firms did not change significantly from 1995 to 1999 although there were significant improvements in a number of the seventeen capabilities (Bowersox et al., 1999). The study found that while the positioning competency of firms improved, with a greater emphasis being given to providing a high level of service to key customers, the decrease in several areas, including supply chain unification, information technology, information sharing, flexibility, process assessment, and benchmarking, was significant. As a result, the new report focuses on the capabilities that facilitate internal and external integration. The attributes included in the 1995 WCL framework were found insufficient for sustainable competitive advantage barely five years later and have been amended by incorporating factors that emphasize integrated relationships and enterprise extension (Bowersox et al., 1999).

Logistics as a Core Competency

The real challenge of today's managers is not merely attaining competitive superiority but maintaining it in the long run. This requires core competencies and efficient change management capabilities. A firm may not gain competitive advantage in the increasingly dynamic global marketplace through its manufacturing excellence alone. This is where logistical competency and the efficiency of the supply chain alliance become critical for sustained competitive advantage. Such firms strive to make logistics management one of their core competencies and position themselves as leaders in the global marketplace. They segment their logistical services by providing different levels of service over and above their pre-existing superior level of basic service (Michigan State, 1995). As a result, they maintain multiple logistics systems concurrently. Through such a strategy, the firm can cocoon its customers and retain them. Customer segmentation is also advantageous because the most demanding customers could be looked upon as a source of innovation and change (Michigan State, 1995). Such a level of synergy reduces the market uncertainty of the customer as well as that of all channel members.

Supply chain alliances are an outgrowth of the core competency emphasis and the challenges of global competition. They are the modern counterparts of vertical integration. They provide the benefits of joint synergy without the risk of ownership. The most basic requirement for alliance development is that the strategic intent of all partners be compatible and complementary. Among world class firms, there is a strong commitment to increase leverage and reduce waste through supply chain alliances. The 1999 study finds that responsiveness, flexibility, speed, dependability and continued sensitivity to cost will be the drivers of competitive advantage in future years (Bowersox et al., 1999).

A firm with advanced supply chain capability will carefully choose its transportation partners so as to position strategically in the global marketplace. Deep-sea movement of raw materials and finished goods still constitutes the most practical and logical way to move a good majority of them over long distances internationally. Although international shipping does not enjoy the privileged status of the previous era as the sole provider of vital transportation services, it remains a significant component of global supply chains as it did then. Liner shipping has a direct effect on the procurement and trading strategies of most firms active in the international business market. They play an important role in the simultaneous fusion of the components of the WCL model and the updated 21st Century Logistics model. As a vital member of global supply chains, they play a paramount role in facilitating world class logistical processes. Hence, the rationale for scrutinizing strategies of liner operators in the context of today's sophisticated business logistics environment.

LITERATURE REVIEW

Many scholars have analyzed the strategies of liner shipping companies. Marx (1953) provides a good description of the strategies of liner companies during the formative years that included industrial self-regulation through conference rate making and service rationalization, and also their strategies to limit both internal and external competition. Deakin and Seward (1973), Evans (1977) and Ellsworth (1979) provided further analysis of those strategies in the early containerization era. Recent contributions in this area include those by Heaver (1996) and Evangelista and Morvillo (2000). Evangelista and Morvillo (2000) paraphrase the competitive liner strategies under the traditional categories of cost leadership and service differentiation. They argue that carriers may pursue their cost leadership strategy to the extent of acquiring other carriers and associate such an initiative at the most advanced stage of development of shipping lines. They identify four levels of logistical integration. At the lowest level, they provide solely maritime activities and then progressively move on to providing port terminal activities, inland transport services and ultimately logistical services beyond transportation. Their notion of service differentiation is

derived through the carrier's involvement in the customer supply chain and is induced by demand fluctuations. They state that shippers' supply chain strategy is changing the role of transportation providers. Their empirical analysis establishes that service differentiation and a high degree of inter-firm integration are relatively incompatible based on the sample they analyzed. They caution against generalizing their conclusion as there are other strategic options open to liner firms that are significantly involved in movements to interior points.

Limitations of the Evangelista/ Morvillo Model

The authors acknowledge that the only models they analyzed were cooperative alliances. Aside from this, the frames of reference used by Evangelista and Morvillo do not convey a complete picture of the contemporary supply chain model. Their usage of the term logistical integration conveys an incomplete message, and the examples they provide barely exceed door-to-door transportation capability, which is only one subset of the logistics system. Furthermore, the inter-organizational integration as referred to by them, cannot extend beyond the lower and medium levels they identified with cooperative shipping alliances. Hence, their empirical conclusion that service differentiation and a high degree of inter-firm integration are relatively incompatible is only to be expected, and a fact of life. Furthermore, as uncovered by the 21st Century Logistics Study (Bowersox et al., 1999), the level of integration accomplished by the top manufacturing businesses themselves is unsatisfactory. That being the case, the relatively low level of inter-firm integration between liner companies and their customers and/or third party logistics service providers is an important albeit low-priority issue and premature for empirical analysis. The shippers themselves have a long way to go with their intra-firm integration prior to solidifying their inter-firm integration. It is suggested that one take a broader look at all liner strategies, and identify those that are congruent with the principles of contemporary supply chain management prior to quantifying the level of integration between liner operators and their supply chain partners.

Methodology

The study will classify contemporary liner strategies into three mutually non-exclusive categories. Each of the strategies will be evaluated in the context of the Michigan State Models of supply chain management. Accordingly, the paper will identify liner strategies that would help the end-to-end distribution needs of their customers and contribute as a partner in the global value chain.

CLASSIFICATION OF LINER STRATEGIES

For the purposes of this study, liner strategies will be classified into three categories, viz., independent, cooperation and integration strategies. A brief description of each of the categories follows next.

Independent Strategy

This is an old strategy and typically used by a new-entrant liner operator. The increasing scale barriers in container shipping have impacted the usefulness of this strategy and with the rare exception of the China Shipping Group, there have been hardly any high profile new entrants in the last few years. Even among the established traditionally independent incumbents, all operators, with the exception of Evergreen, have joined one or more co-operative alliances. Evergreen's niche is its cost leadership, and focuses primarily on port-to-port and round-the-world services. It offers limited door-to-door services using contractual agreements. While Evergreen may indeed become a long-run supply chain partner of one or more of their customers, it is unlikely that their role will extend beyond their core competency of providing traditional liner services. Furthermore, an independent may make use of integration strategies to position themselves as a cost-effective global carrier as illustrated by Evergreen's acquisition of Lloyd Triestino of Italy. For these reasons, the

independent strategy is excluded from further analysis although conceptually it would fit well with a customer's desire to negotiate individually with their supply chain partners.

Cooperative Strategies

Cooperative strategies are strategies pursued by liner operators to bring down their costs and enhance their capacity utilization. These include conferences and consortia as well as their recent incarnations of discussion agreements and alliances, respectively. Although conference agreements play a significant role in the north-south trades in particular, their role in arterial trade routes that include U.S. ports has been curtailed drastically and replaced by discussion agreements (Beargie, 2000). By their nature, a traditional conference agreement goes against the principles of contemporary logistics models. Membership in a liner conference creates a poor impression among one's customers today rather than being the trademark of a quality service-provider. It would be perceived by today's shipper community as an example of the non-customer orientation of liner operators and hence, not in congruence with the contemporary supply chain management practices. As a result, their demise from the major trade routes characterized by shippers with sophisticated logistical needs is understandable. By the same token, the flexibility of discussion agreements makes them relatively tolerable for those shippers although there is a strong likelihood of their coming under increasing regulatory scrutiny (Beargie, 2000).

Cooperative strategies help liner operators to utilize their resources better and reduce their operating costs. The British and other West European shipping lines have been the traditional proponents of asset sharing. U.S.-based shipping lines historically stayed away from such activities for maintaining their operational freedom. The American companies resorted to various in-house techniques to control their costs rather than entering into consortia and other cooperative working arrangements (which their competitors elsewhere did). It became clear to them in the early 1990's that individual cost-control measures could only go so far and further savings require greater cooperation. This led to a literal explosion of strategic alliances in liner shipping beginning in the mid-1990's (Fossey, 1994; Damas, 1996; and Phillips, 1996). Operators look for the ideal partner(s) with whom to combine their resources in the most effective manner whether those are ships, port terminals or sailing schedules. All major liner routes are dominated today by one or more carrier alliances.

The alliances between container operators generally improve the service frequency and reduce the transit time in key port-to-port corridors. This is vital for shippers who demand more frequent services on the busier sub-trades as it enables them to reduce their investment in inventory. The extensive geographical coverage of an alliance provides all partners with a greater choice of direct port calls. Through careful streamlining of joint services, it is possible to lower port and feeder service-related costs. Other possibilities include the potential for sharing of containers, chassis, equipment and terminals, shared use of feeder vessels, and streamlining of land-based intermodal services. Thus, liner operators stand to gain an overall increase in operating efficiency and some monetary savings through their alliances that could be passed on to their customers. However, there are significant hurdles in the path towards alliance implementation, especially in the non-shipping sector. The level of difficulty associated with vessel and terminal sharing is rather low compared to that associated with other implementation steps, in particular those related to inland operations (Kadar, 1996).

Detractors of alliances point towards the increasing concentration in the sector. Initial reaction to this strategy was that it was merely a marketing gimmick, loading half the ship twice a week rather than loading the whole ship once a week. After a few years of experience, the consequences of liner alliances appear more daunting. Services such as the post-Panamax pendulum, a combination of all major east-west

arterial trade routes linking Asia with the U.S. West Coast and Europe and/or U.S. East Coast through the Suez Canal, are provided by the alliances. Such services raise strong entry barriers for all but the exceptionally strong independents (like Evergreen Lines of Taiwan). It has been observed that carrier alliances only look inward and do not focus on the needs of the customer or the supply chain, and lack customer-orientation (Berzon, 1996). Furthermore, as these arrangements do not truly rationalize excess tonnage, those carriers that embraced alliance-formation as the panacea for all their ills are likely to be disappointed. By the same token, the alliances will only work as long as the partners maintain their comparable competitiveness and efficiency. There is no guarantee that this strategy will be anything more than a short-run arrangement as is well illustrated by the frequent shuffling of alliance partners for immediate operational gains. As a result, membership in a global alliance or a consortium also has limited value from a contemporary supply chain perspective. It is unlikely that this strategy would be particularly appealing to a customer intent on building long-lasting supply chain alliances.

Integration Strategies

The study will analyze vertical and horizontal integration strategies of liner operators as they have a direct relevance to the provision of global supply chains.

Vertical integration. Historically, it has been argued that it was the introduction of liner shipping in the early nineteenth century that eliminated the need for integrating merchant and deep-sea shipping (Casson, Barry, and Horner, 1986). Casson and his team studied 28 shipping companies operating in, or controlled from the UK. The study found that a significant number of the shipping companies were involved in agency services, freight forwarding, stevedoring, warehousing, providing port facilities, road haulage and distribution. Casson credits the above developments to the operational flexibility introduced through containerization, and emphasizes that containerization has strengthened the incentive to integrate shipping with other modes of transportation and port facilities (1986).

The unitization of liner cargo by using ISO marine containers opened up a plethora of opportunities for liner operators. The use of large container vessels gave them the necessary economies of size in their deep-sea shipping movements without unduly prolonging the time spent in port. With the elimination of legal impediments to intermodalism, human ingenuity began to overcome the traditional boundaries of liner service that until then did not extend beyond the immediate vicinity of ports. Thus, with the arrival of the intermodal era, a new cycle of innovation began in liner shipping. Intermodal systems began to emerge and establish under the leadership of liner companies. It necessitated the coordination of ship arrival times with train schedules and their expeditious inland movement. But, the traditional liner feature of encouraging service competition made it imperative that intermodal capability be a competitive essential rather than a mere option. As cargo volumes reached a critical level, deep-sea liner operators began to take over the operations of their intermodal associates with the twin goals of expanding their area of control and reducing their costs. When one liner operator establishes itself as a multi-modal entity, competing firms are compelled to undertake similar operations. In addition to the acquisition of inland transportation companies, other vertical integration efforts by liner shipping companies have included warehouse and distribution centers, freight forwarders, customs-house brokers, and EDI firms. The transition of liner operators into total transportation entities has been referred to as one of the most exciting developments of the intermodal revolution (McKenzie, North, and Smith, 1989).

However, this strategy began to backfire in the late 1980's and early 1990's. As the intermodal systems of vertically integrated liner operators began to mature, their profitability began to decrease rather than increase. The reasons cited

for this includes the excess capacity in liner markets and the alleged cross-subsidization of inland moves by the deep-sea leg. Furthermore, it appears that some liner operators made some acquisitions that were not integrated even after a prolonged period of gestation. They simply acquired channel members purely to keep up with their competitors, or out of grand expectations of creating the best vertically integrated transportation structure. This led to significant restructuring of top liner companies like American President Companies, Sea-Land, Nedlloyd and P&OCL that began in the early 1990's and is still continuing as illustrated by the recent sale of the APL stack-train services. The top tier liner operators are thus streamlining their investments and finetuning their networks.

There are fundamental concerns associated with the vertical integration strategies of liner operators. Part of this stems from the inherent incompatibility between the deep-sea mode and the land-based modes of transportation. Shipping has high fixed costs and low variable costs while the land-based modes of transport have low fixed and high variable costs (Wood and Johnson, 1995). This results in significant economic incompatibility when a liner operator attempts to run its vertically integrated operation. Furthermore, shipping companies have a very traditional hierarchical management structure whereas running an in-house integrated (liner-oriented) supply chain requires more of a team-based, horizontal management structure. Thus, this liner strategy, although ideally suited for facilitating global supply chains, is not easy to implement and requires a virtual catharsis of traditional liner management philosophy.

Horizontal integration. It was believed initially for many reasons that containerization would reinforce the conference system and its market power (Davies, 1990). Liners began horizontal integration as a means of amassing the huge investments required in providing an efficient, containerized liner service. Financial interests and even governmental interests have promoted the operational integration of container operators under their jurisdiction to attain economies of scale in the environment that containerization spawned (UNCTAD, 1970).

Although one could conjure different variations of the horizontal integration theme, the only model considered here is a merger or acquisition involving liner companies. An examination of such activities in the liner sector shows two divergent trends that a recent trade journal categorized as the full integration type and the multi-brand "federal" type (*Lloyd's Shipping Economist*, 2000). Examples of the first category include the creation of P&O Nedlloyd Lines, the NOL-APL merger and the Maersk-Sealand merger. All these mergers have resulted in the creation of a single entity that has had a remarkable impact on the rest of the players, including the disruption of the alliance structures in the first two cases. The "federal" model implies that the parent company oversees the activities of one or more independently operated autonomous subsidiaries. Separate brand names are maintained and run as individual lines as in the case of CP Ships, Hamburg Sud and CSAV. There is little empirical evidence to support the superiority of one model over the other. In general, this strategy is also designed to lower the unit cost of operation through gains in economies of scale very similar to that of the cooperative strategies discussed earlier. However, it provides greater control in the decision making process albeit at a heightened level of business risk. While there are likely to be even more defensive takeovers in the market, the impact of this strategy from a global supply chain perspective is unclear. However, one can conjecture that the emergence of a merged strong operator (such as the P& O Nedlloyd Lines, or the new APL brand, or Maersk-Sealand) with global capability is attractive to a shipper with sophisticated supply chain demands. This is especially the case when these operators also possess significant end-to-end distribution capability besides having an exceptionally well-positioned core competency. Such capabilities are irrelevant unless the carrier exhibits the willingness and flexibility to work with their customers and design tailored logistics packages. This would have been

unlikely but for the introduction of recent regulatory changes, and are discussed briefly next.

CHANGES IN LINER REGULATORY ENVIRONMENT

The global supply chain environment underwent dramatic changes resulting from recent institutional interventions in the liner market. Specifically, the U.S. Shipping Act of 1984 was amended by the Ocean Shipping Reform Act of 1998 (OSRA) and partially deregulated the liner services in the U.S. foreign commerce. Although the amendments enacted are numerous, the ones that have a greater impact from a supply chain perspective are related to the introduction of confidential service contracts.

The service contract provision is the most deregulatory component of the new legislation. It has expanded the scope and purpose of service contracts from the original 1984 Act and made it a truly powerful marketing tool for shipping companies to differentiate their services from their competitors. The new service contract provision allows the co-existence of a discriminatory contract carriage system with the common carriage objectives of the tariff system. Although contracts need to be filed confidentially with the Federal Maritime Commission (FMC), except for contracts on exempt commodities, the previous requirement to file essential terms of a service contract in tariff format for public review is seriously curtailed. Strategic components of a service contract such as inland points for intermodal movements, freight rates, service commitments and liquidated damages for non-performance can now remain confidential. Conferences and consortia will not have the right to restrict its members from negotiating individual contracts with shippers although they may issue voluntary guidelines relating to terms and procedures for such contracts. The voluntary guidelines must be submitted to the Federal Maritime Commission. Another significant departure from the 1984 Act is that a contract may be based on percentage of cargo of the shipper, not permissible earlier because of its connotation to a loyalty contract. Loyalty contracts are still illegal under OSRA. However, OSRA has altered the definition of such contracts to one that includes a deferred rebate. Individual shippers, shippers' association as well as a group of unaffiliated shippers may enter into service contracts. Similarly, a group of carriers other than a conference is also allowed to enter into service contracts.

Although the new service contract provision allows shippers to sign confidential service contracts of a global nature, shippers and carriers have been slow to change their business practices because of their lack of familiarity with the new freedoms. An informal FMC survey found that 83% of 408 contracts filed by the top 13 ocean common carriers in the U.S. foreign trades lacked confidentiality clauses and only 77% of the remaining 17% required complete confidentiality (Beargie, 2000). Furthermore, a majority of the contracts are still negotiated during four to six weeks in early spring and many contracts are still confined to a single trade route with duration of one year or less and there are very few customized contracts. It is important to note that operators such as Maersk-Sealand are reporting a higher than anticipated number of global contracts (Beargie, 2000). As these cargoes are typically high value items and account for a higher percentage based on overall cargo volume, it is possible that such contracts will lead to dedicated supply chain alliances in the future. Maersk Logistics (Gillis, 2000) and APL Logistics are two outstanding examples of integrated supply chain initiatives currently available to international shippers.

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

The paper discussed developments in contemporary supply chain models such as the world class logistics (WCL) model and the 21st Century Logistics Model. It also scrutinized three major categories of generic liner operating strategies. All strategies have their respective pros and cons when viewed in the context of establishing global supply chain alliances. Even the much maligned

conference strategy has the advantage of providing regular and reliable services at predictable freight rates. The most basic incongruity arises when shipper clients are unable to deal one-on-one with their liner shipping partners. Ideally, the vertically integrated independent liner operators would provide the best fit and be most congruent in supply chain alliances as they could possess logistical capability as well as flexibility. A vertically integrated liner operator who is capable of providing consistently reliable and tailored end-to-end distribution services will be a true asset in any world class firm's supply chain. However, that strategy, attempted by a handful of liner operators in the late 1980's and early 1990's, turned out to be structurally incompatible with liner economics and organizational structure in the real world. Accordingly, this is not a feasible option for shippers today. The next best option for transportation managers is to seek a liner operator pursuing a horizontal integration strategy through mergers and/or acquisitions. The partial deregulation of liner services in the U.S. provides the right environment for these initiatives to pursue the challenge of integrated supply chain partnerships. Top tier liner operators are making good use of this strategy and also investing in powerful information systems, another prerequisite for efficient supply chain management. These global operators focus on creating vertical alliances with their land-based counterparts and streamline their joint operations in providing customized end-to-end distribution services for their customers. Thus, they are on the right course to providing a variety of value-added services despite shedding some of their initial land-based assets. These firms are well positioned to benefit from the sophistication of their logistical capability as they can provide tailor-made services for their world class clients in the new millennium and embark on a strong era of global supply chain alliances.

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3. Third Page—Title of the paper without author name(s) and a brief abstract of no more than 100 words summarizing the article. The abstract is used on the Contents page of the JTM and serves to generate reader interest in the full article.

FORMATTING

1. Manuscripts should be typed, double-spaced (body of text only), on white 8 ½ by 11 inch paper.

2. Submit four (4) paper copies of the manuscript for review. It is not necessary to send a disk for the initial review. However, to save time and effort if accepted, the article should be prepared using either:

   WordPerfect ***9.0 or lower***
   OR
   Microsoft Word ***2000 or lower***

3. Accepted articles, in final form, are to be submitted on disk (in WordPerfect or Microsoft Word format as described above) and in hard copy. Note: Macintosh versions of WordPerfect and Microsoft Word are NOT acceptable.

4. The entire manuscript should have 1" margins on all sides in Times 10-point font. Times New Roman or Century Schoolbook are both acceptable.

5. The entire manuscript must be typed LEFT-JUSTIFIED, with the exception of tables and figures.

TITLE PAGE AND ABSTRACT

1. The manuscript title should be printed in Times 11-point and in all capital letters and bold print.

2. Author(s) and affiliation(s) are to be printed in upper and lower case letters below the title. Author(s) is(are) to be listed with affiliation(s) only.

3. The abstract should be 100 words or less.

BODY OF MANUSCRIPT

1. Main headings are bolded and in all caps.

2. First level headings are upper/lower case and bolded.

3. Second level headings are upper/lower case.

4. The body is NOT indented, rather a full blank line is left between paragraphs.

5. A full blank line should be left between all headings and paragraphs.

6. Unnecessary hard returns should not be used at the end of each line.

TABLES AND FIGURES

1. ONLY Tables and Figures are to appear in camera-ready format! Each table or figure should be numbered in Arabic style (i.e., Table 1, Figure 2).

2. All tables MUST be typed using either WordPerfect table or Microsoft Word table functions. Tables should NOT be tabbed or spaced to align columns. Column headings should not be created as separate tables. Table titles should not be created as part of the table. All tables MUST be either 3 1/4 inches wide or 6 7/8 inches wide.

3. All figures MUST be saved in one of these formats: TIFF, CGM, or WPG.

4. Tables and figures are NOT to be included unless directly referred to in the body of the manuscript.

5. For accepted manuscripts, tables and figures must be included on the submitted disk and each should be printed on a separate page.

6. Placement of tables and figures in the manuscript should be indicated as follows:

Table or Figure About Here

EQUATIONS, CITATIONS, REFERENCES, ETC.

1. Equations are placed on a separate line with a blank line both above and below, and numbered in parentheses, flush right. Examples:

$$y = c + ax + bx \quad (1)$$

$$y = a + 1x + 2x + 3x + ax \quad (2)$$

2. References within the text should include the author's last name and year of publication enclosed in parentheses, e.g. (Cunningham, 1993; Rakowski and Southern, 1996). For more than one cite in the same location, references should be in chronological order, as above. For more than one cite in the same year, alphabetize by author name, such as (Grimm, 1991; Farris, 1992; Rakowski, 1992; Gibson, 1994). If practical, place the citation just ahead of a punctuation mark. If the author's name is used within the text sentence, just place the year of publication in parentheses, e.g., "According to Rakowski and Southern (1996)...,". For multiple authors, use up to three names in the citation. With four or more authors, use the lead author and et al., (Mundy et al., 1994). References from the Internet should contain the date the page/site was created, date page/site was accessed, and complete web address.

3. Footnotes may be used when necessary. Create footnotes in 8-point font and place them at the bottom of the page using numbers (1, 2, etc.). Note: footnotes should be explanatory in nature and not for reference purposes.

4. All references should be in block style. Hanging indents are not to be used.

5. Appendices follow the body of the text but do not precede references.

6. The list of references cited in the manuscript should immediately follow the body of the text in alphabetical order, with the lead author's surname first and the year of publication following all author names. Work by the same author with the same year of publication should be distinguished by lower case letters after the date (e.g., 1996a). For author names that repeat, in the same order, in subsequent cites, substitute a .5 inch underline for each name that repeats. Authors' initials should have a space between the initials, e.g., Smith, Jr., H. E., Timon, III., P. S. R., etc. A blank line should separate each reference in the list. Do not number references.

7. All references to journals, books, etc. are *italicized*, NOT underlined. Examples are as follows:

Journal Article:

Collison, Fredrick M. (1994), "Transpacific Air Service with Hong Kong: Characteristics and Issues," *Journal of Transportation Management*, 6(2):1-39.

Book Chapter:

Hatch, R. W. (1923), "A Program for the Social Studies in the Junior and Senior High Schools," In G. M. Whipple (Ed.), *National Society for the Study of Education Yearbook 1922* (Pt. 2, pp. 126-154) Bloomington, IL: Public School Publishing.

Book:

Johnson, James C. and Wood, Donald F. (1996), *Contemporary Logistics*, 6th ed., Upper Saddle River, NJ: Prentice-Hall, Inc.

Internet Reference:

Lankard, B. A. (1995), "Service Learning," *Eric Trends and Issues Alerts*, [Online]. Available: http://ericave.org/docs/service.thm. Accessed: 3/2/00.

MANUSCRIPT SAMPLE

TEACHING LOGISTICS STUDENTS TO TAKE OWNERSHIP OF INFORMATION INFRASTRUCTURE DEVELOPMENT

Frank W. Davis, University of Tennessee
Kenneth J. Preissler, Logistics Insights Corporation

Logistics systems, developed gradually over the past decades, are undergoing necessary radical change in this era of increasing global competition. This article describes an approach taken by the authors to teach logistics students how to take ownership of designing their own information infrastructure and how to use it to make their organizations more flexible, providing more strategic options.

INTRODUCTION

Advances in information systems technology such as data base management systems, bar code scanning, telecommunications, and image processing have enabled logistics and information managers with vision to reengineer the way the firm conducts its business. The usage of mainframe computers, personal computers, and logistics information systems has been widely studied (Gustin 1989). These studies have universally concluded that there has been a rapid growth in the usage of computers and logistics information systems.

Computer Usage in the Classroom

The usage of computer applications in a logistics course has also been studied. Rao, Stenger and Wu stated that there are several approaches to integrating computers into the classroom in a business curriculum, each with its individual advantages and drawbacks (1992).

Table 1 about here

Systems Development in Practice

The study of the information systems development process of computer applications has been almost universally left up to the computer science, software engineering, and information systems educators and practitioners.

$$y = a^2 - 2ax + x^2 \qquad (1)$$

REFERENCES

Collison, Fredrick M. (1994), "Transpacific Air Service with Hong Kong: Characteristics and Issues," *Journal of Transportation Management*, 6(2):1-39.

Crum, M. R. (1996), "On the Improvement of Carrier EDI Implementation Strategies," in *EDI Implementation in the Transportation Industry*, New York: Transportation Press, 387-404.

Johnson, James C. and Wood, Donald F. (1996), *Contemporary Logistics*, 6th ed., Upper Saddle River, NJ: Prentice-Hall, Inc.


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